Draft Environmental Impact Statement

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CONSOLIDATION
COAL COMPANY

CX Ranch Mine
Big Horn County, Montana

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Montana Department of State Lands
U.S. Office of Surface Mining / U.S. Bureau of Land Management

OSM-EIS-20

Type of Statement

Draft Environmental Impact Statement

Lead Agencies

State of Montana, Department of State Lands

U.S. Department of the Interior, Office of Surface Mining Reclamation and Enforcement

Cooperating Agency

U.S. Department of Interior, Bureau of Land Management

Proposed Action

Approvals to mine 1,905 acres at Consolidation Coal Company's CX Ranch Mine.

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Environmental Impact Statement

Consolidation Coal Company's

CX RANCH MINE

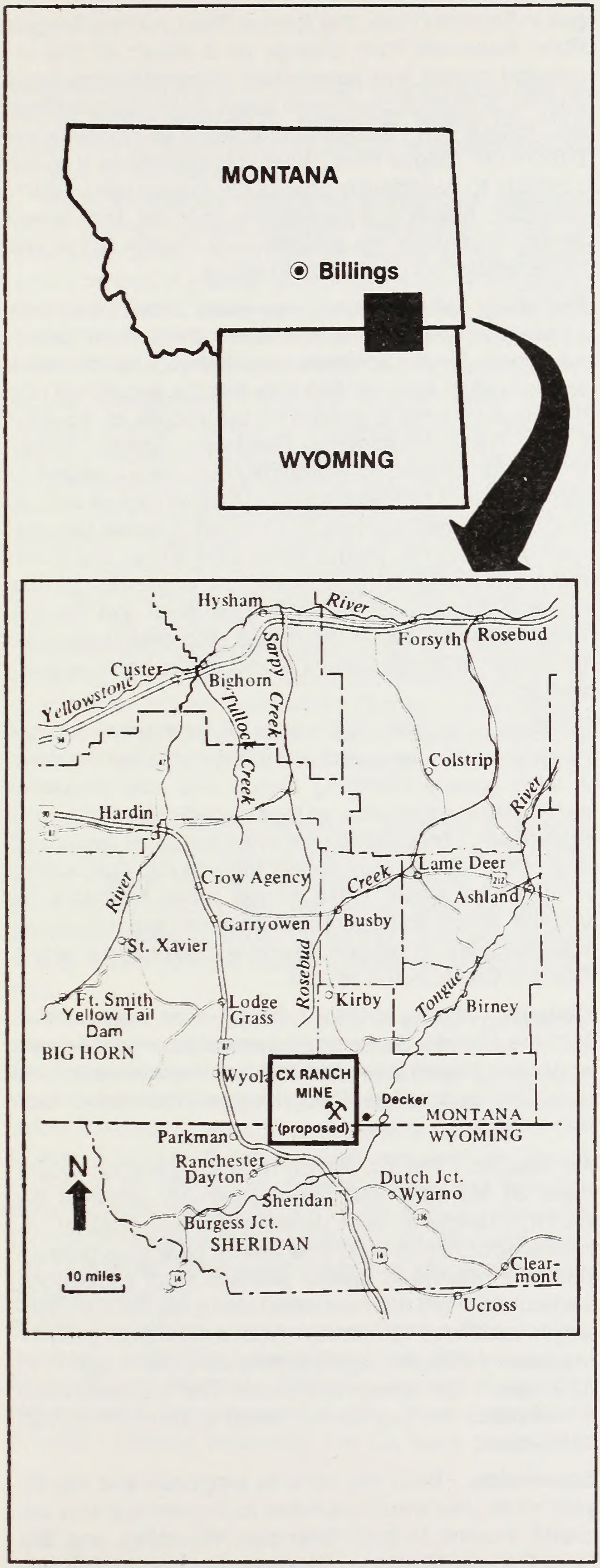
Big Horn County, Montana

April 1985

Montana Department of State Lands
Dennis Hemmer, Commissioner

John A. Ward
U.S. Office of Surface Mining
John Ward, Director

OSM-EIS-20



SUMMARY

Action Under Consideration

Consolidation Coal Company (Consol) has submitted an application to open a 1,905-acre coal strip mine near Decker in Big Horn County, Montana. The Commissioner of the Montana Department of State Lands and the Secretary of the U.S. Department of the Interior must decide whether to approve the application as submitted by the company, to reject the application, or to approve the application with special conditions.

The Company's Proposal

Consol proposes to mine 47 million tons of coal over 12 years from a 429-acre mine pit. About 600 people would be required to construct and operate the mine. If the company receives additional coal leases in a pending decision, the mine would expand considerably: The mine life would extend to 33 years, the pit would expand by as much as 2,000 acres, the amount of coal mined would rise to 332 million tons, the coal production rate would reach 16 million tons per year, and the number of employees would climb to 940.

Along with the CX Ranch Mine, as many as 10 other coal mines could eventually operate in the Sheridan-Decker area. As a result, the analysis in this environmental statement includes a discussion of cumulative impacts, or the impacts the mines would have together. All 11 possible mines are included in the evaluation of cumulative impacts on hydrology. Only the mines in Montana and the Big Horn Mine in Wyoming are included in the cumulative scenario for the socioeconomic topics.

Summary of Impacts

Geology. After mining, the topography of the minesite would be slightly gentler than today. Minor gullies would probably develop, but would not restrict postmining land uses. Erosion rates would probably be the same as or less than existing rates. Impacts from unsuitable overburden would be minimal.

Hydrology. The CX Ranch Mine would have two main hydrologic effects: First, mining would change water levels and water quality in wells near the mine. Three wells would be removed by the mine and six others would probably be affected by water level declines or water quality deterioration. Any wells rendered unusable by mining would be replaced by the company.

Second, pit water discharges would worsen surface water quality of Squirrel Creek and the Tongue River. Discharges would probably double or triple the creek's average ammonia concentrations, although greater temporary increases are likely. Nitrate concentrations would probably increase even more. Sodium levels would increase dramatically. Ammonia and nitrate/nitrite concentrations in the Tongue River would also rise, but much less than for Squirrel Creek (under 5 percent in average conditions, but up to 30 percent in extreme circumstances). Development of up to 11 mines above the Tongue River Reservoir could more than double ammonia and nitrate/nitrite concentrations in the river.

Soils. Consol would salvage enough good quality soil for successful overall plant growth after reclamation. Prolonged soil storage, however, would biologically degrade the soil, and this could lower postmining vegetative vigor and diversity for an unknown period of time. Unavoidable soil impacts would include loss of the natural soil profile and pore space continuity, an overall reduction in pore space, a breakdown of soil structure, and a reduction in organic matter concentration. During mining, increased sodium levels in Squirrel Creek could adversely affect soils and vegetation next to the creek.

Vegetation. Biological impacts on soils due to prolonged storage could lower postmining vegetative diversity and vigor for an unknown time period following reclamation. During mining, increased sodium levels in Squirrel Creek could adversely affect vegetation growing next to the creek.

Aquatic Ecology. The species composition and productivity of macroinvertebrates (aquatic bugs) and algae in Squirrel Creek, the Tongue River, and the Tongue River Reservoir may change as a result of the increased nitrate and ammonium concentrations from mining. A change could also occur in the Tongue River and Tongue River Reservoir if as many as 11 mines are built in the Tongue River Reservoir watershed. It is not possible to confidently predict the magnitude of such changes; however, calculations indicate that water quality criteria for the protection of aquatic life would be exceeded during certain seasons.

Fisheries. Mining discharge water would increase concentrations of toxic un-ionized ammonia in Squirrel Creek. Under extreme conditions, the increase would lead to summer fish kills and the avoidance of a potential spawning ground at the mouth of Squirrel Creek. The Environmental Protection Agency 30-day criteria for un-ionized ammonia could be exceeded in Squirrel Creek, depending on combinations of ammonia, pH, and temperature. If 11 mines operate simultaneously along the Tongue River, EPA 30-day and maximum allowable criteria would be exceeded (under extreme conditions) in the Tongue River and Tongue River Reservoir. When the mines stop discharging pit pumpage, affected waters would again become suitable for fish.

Wildlife. Roughly 150 acres of pronghorn winter range would be removed by mining in the permit area. A sage grouse wintering area would also be eliminated. Regional effects on these species would not be significant. Three raptor nest sites would be destroyed and other raptors may desert their nests. Successful reclamation would make mined areas habitable by wildlife, although populations of some species would take decades to recover. Some wildlife habitat along Squirrel Creek would be lost.

Climate. Mining at the CX Ranch Mine would not affect the climate. Suspended particulate would remain at or near ground level, and total particulate emissions would be too small to affect either precipitation or radiation balance.

Air Quality. The CX Ranch mining operation would meet all Montana and Federal primary Ambient Air Quality Standards, even during maximum production. However, during at least one year of peak coal production, the maximum annual average total suspended particulate (TSP) concentration along the Decker highway is predicted to increase from a maximum premining level of 29.9 micrograms per cubic meter ($\mu g/m^3$) to 63.2 $\mu g/m^3$. The greatest 24-hour TSP concentration would reach 126.3 $\mu g/m^3$, compared to a premining high of 94 $\mu g/m^3$.

Economics. Both the mine as proposed and the 33-year mine plan would increase total personal and per capita income in both Sheridan, Wyoming, and Big Horn County, Montana. Because most new mine employees would settle in Sheridan County, most new income would accrue to Wyoming residents. High wages in the mining industry are not expected to affect wages in other sectors.

The effects of the cumulative scenario on Sheridan County would closely resemble the effects of the 33-year plan. In Big Horn County, Montana, the reverse would be true. A greater proportion of Big Horn County residents would be employed in the cumulative scenario than in the CX Ranch scenarios. The county's total and per capita income would thus increase greatly.

Social Conditions. The CX Ranch Mine would slightly change the social organization and increase the population and housing demand in the Decker and greater Sheridan areas, mostly in the 33-year mine plan during the years 2000 through 2010. Other regional areas would not be significantly affected by the mine.

Development in the cumulative scenario would significantly increase the population and housing demand in the Decker area, Sheridan City, greater Sheridan area, and Ranchester-Dayton. Social organization would be substantially affected in the Decker area and, to a smaller degree, in Sheridan City, the greater Sheridan area, and the Ranchester-Dayton area. Cumulative scenario effects would peak during the years 2000 through 2010.

Social and Community Services. As a result of population growth from the CX Ranch Mine, Sheridan City would need a few more service personnel, education facilities, hospital beds, and some facilities associated with housing development (e.g., sewer, water). The communities can meet these needs without hardship.

As a result of population growth in the cumulative scenario, several communities would need even more service personnel and facilities. Sheridan City would need more park acreage, roads, water storage capacity, water treatment capacity, and general administrative space. Sheridan County would need more school space, shop space, fire station space, and hospital beds. Ranchester would need more park acreage and Dayton more parks, roads, sewage collection and treatment capacity, general administrative space, and water storage capacity.

Fiscal Conditions. More mines in the Decker area would aggravate the current fiscal imbalance between Montana and Wyoming: While spending created by mine-related development would grow sharply in Sheridan County, Wyoming, the tax base created by mining would grow mainly in Montana. As a result, Sheridan County would suffer financial strain and Big Horn County, the State of Montana, and the Federal government would benefit substantially. The Crow Tribe would benefit financially from the Youngs Creek Mine, a mine in the cumulative scenario, but would be unaffected by the CX Ranch Mine.

Land Use Patterns. Most impacts on land use from mining would be confined to the minesite. Effects outside the mine would be minor, not noticeably changing land use patterns in either Big Horn or Sheridan Counties. Over the life of the mine, 2,974 acres that are committed to a variety of agricultural land uses would temporarily be converted to mining uses. In the cumulative scenario, an additional 1,465 acres of agricultural land would be disturbed by the neighboring Wolf Mountain Mine.

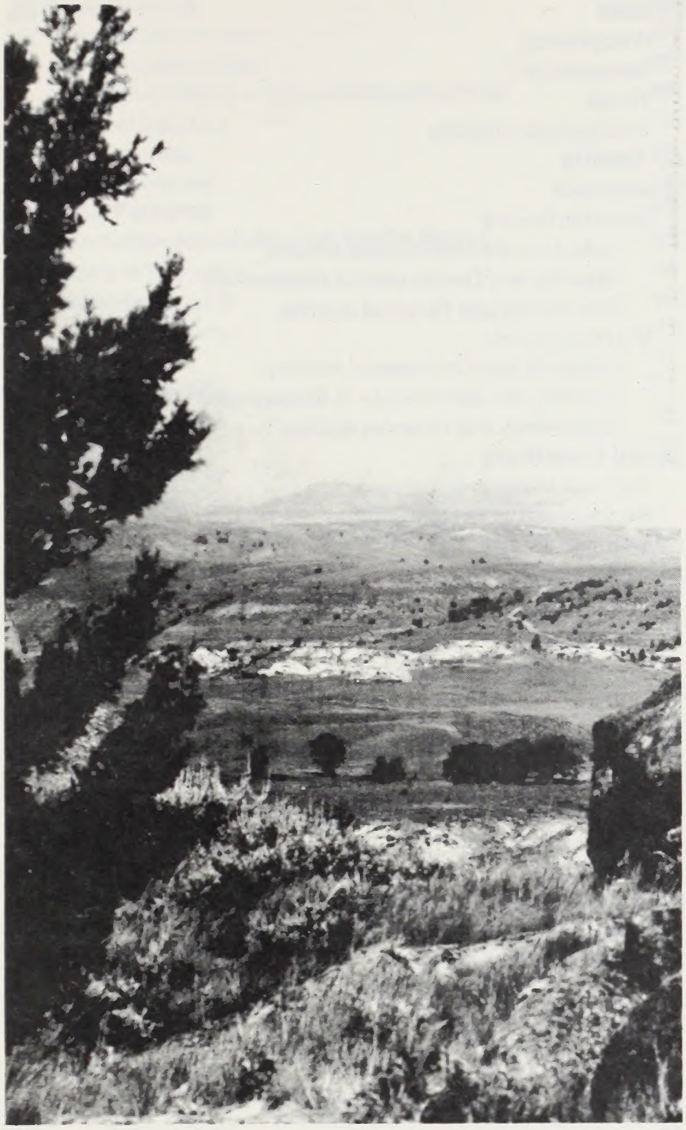
Transportation Networks and Traffic Flow. The location of the access points to the proposed mine would have a shorter than recommended view of oncoming traffic. Relocating the access points would mitigate this problem.

A related effect of increased coal production would be more unit coal trains passing through the region. The greatest impact, particularly in the cumulative scenario, would be increased delays at the Fifth Street crossing in Sheridan. Another effect would be increased traffic on Wyoming 338 and FAS 314. The accident rate (number of accidents per million vehicle miles), however, is not expected to change.

Outdoor Recreation. Neither the CX Ranch Mine nor the development projected in the cumulative scenario would significantly affect recreation in the region. Specific popular sites, on the other hand, may become overcrowded and overused.

Cultural Resources. Mining would damage or destroy six prehistoric cultural resource sites potentially eligible for the National Register of Historic Places. In addition, nine prehistoric and three historic potentially-eligible sites in the buffer zone may be indirectly affected by mining, collecting, vandalism, or blasting.

Aesthetics. Aesthetic impacts at the CX Ranch Mine would not be significant after reclamation. Although the postmining landscape would have gentler topography with fewer sandstone outcrops and sharp breaks, the landscape would not, after several decades, contrast greatly with unmined lands.



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THE EIS: WHY IT IS WRITTEN, WHO TAKES PART, WHAT DECISIONS MUST BE MADE

Consolidation Coal Company (Consol) proposes to build an open pit coal mine 2 miles west of Decker, Montana, near the southern border of Big Horn County, Montana. The mine would be known as the CX Ranch Mine. Before beginning operations, Consol must obtain a surface mining permit from both the Montana Department of State Lands, in accordance with the Montana Strip and Underground Mine Reclamation Act, and the U.S. Department of the Interior, in accordance with the Surface Mining Control and Reclamation Act. Within the Department of the Interior, the Office of Surface Mining Reclamation and Enforcement (OSM) is the lead agency.

THE EIS

The Department of State Lands (DSL) and the U.S. Department of the Interior (DOI) have determined that the proposed mining and reclamation plan may "significantly affect the quality of the human environment." Therefore, before making a decision on the company's permit application, the agencies are required to prepare an environmental impact statement (EIS) (Montana Environmental Policy Act [MEPA], 1971, and National Environmental Policy Act [NEPA], 1969).

As required by the Montana and National Environmental Policy Acts, the agencies must follow a detailed procedure that includes—

- issuing this draft EIS.
- encouraging and accepting public comments on the draft.
- issuing a final EIS that contains—
  (1) corrections or clarifications of the draft EIS
  (2) responses to each public comment.

After publishing the final EIS, the agencies must make a decision on Consol's application. The Department of State Lands can make a decision no sooner than 15 days following publication of the final EIS; the Department of the Interior can make a decision no sooner than 30 days following publication of a notice by the U.S. Environmental Protection Agency that the final EIS is available for review.

The EIS analyzes (1) the company's proposal, (2) the lands, people, and resources that the proposal would affect, and (3) the consequences (or impacts) of the proposal. The EIS does not present the agencies' decision. The document is used as one of the tools in making the decision. The preparation of the EIS helps assure that the proposed operation is well planned, that the environmental impacts of the proposed action are analyzed, and that the concerns of all agencies, organizations and citizens are considered before a decision is made.

SCOPE OF ANALYSIS

In May 1982 the Department of State Lands and the Office of Surface Mining mailed 500 questionnaires to people interested in the CX Ranch and Wolf Mountain Mines. Soon thereafter, June 9, 1982, the agencies held a public meeting on the proposed mines in Sheridan, Wyoming. Concerns raised at the meeting and in the 10 questionnaires that were returned are listed below. These concerns, and those of the Department of State Lands and Office of Surface Mining, are evaluated in the EIS.

- How successful have coal companies been in reestablishing coal aquifers after mining? How would the quality and quantity of ground and surface waters change? Would the water be similar to what existed before mining?
- Where would mine and construction workers come from and live? Are there adequate housing and services to support a large population influx? How would the mine affect secondary schools?
- What would impacts be to State Highway 314 and other major roads? Would there be plans for mass transportation to alleviate increased traffic effects? Would local roads be used to haul machinery and equipment? What would the impacts of this be?
- Is the over-the-highway conveyor the safest and most economical method of delivering coal to the loadout? Would its construction and maintenance inconvenience highway travelers?
- What are Consol's plans for shipping coal? What disturbances would be created by the coal trains? How would the disturbances be mitigated?
- Will the EIS address the life of the mine? In what detail?
- The Northern Cheyenne Indian Tribe maintains it is experiencing cumulative impacts from mining in the region. How would the road system needed to get the labor force to the mine affect the availability of skilled and unskilled Northern Cheyenne labor?
- Is precipitation a major limiting factor to reclamation success near Sheridan? How would the chemical and physical properties of the soil and overburden affect reclamation?
- Would blasting at the mine affect ground water wells?
- Do minerals other than coal lie within the CX Ranch? Would their recoverability be affected by coal mining?
- How would the mine affect nearby landowners? Would property values decline?
- Will an agreement be worked out between Montana and Wyoming for redistribution of tax revenues from mining? That is, would taxes paid to the State of Montana and Big Horn County be available to offset mining's socioeconomic impacts in Sheridan County?
- Is there a need and a market for the additional coal?
- How would a new mine affect the mines now in operation? What would happen to coal markets, wage scales, and the availability of rail transportation, power, water, labor, and housing?
- How would mining affect fish and wildlife?
- Would mining affect alluvial floors such as those of Tongue River and Little Youngs Creek?
- Would iron, boron, and ferrous sulfide contaminate the ground water pumped from the mine. Would water for irrigation, livestock, and domestic needs be ruined forever?

In answering these questions, the EIS analyzes both the immediate and cumulative effects of Consol's CX Ranch mining and reclamation plan. Included in the analysis are the impacts the mine would have on the physical environment—on soils, vegetation, water quality, air quality, and a number of other resources. Also included are impacts on the human environment—on land use, fiscal conditions, social conditions, and cultural resources. The text generally covers both the impacts of mining and those resulting from increases in employment and economic activity.

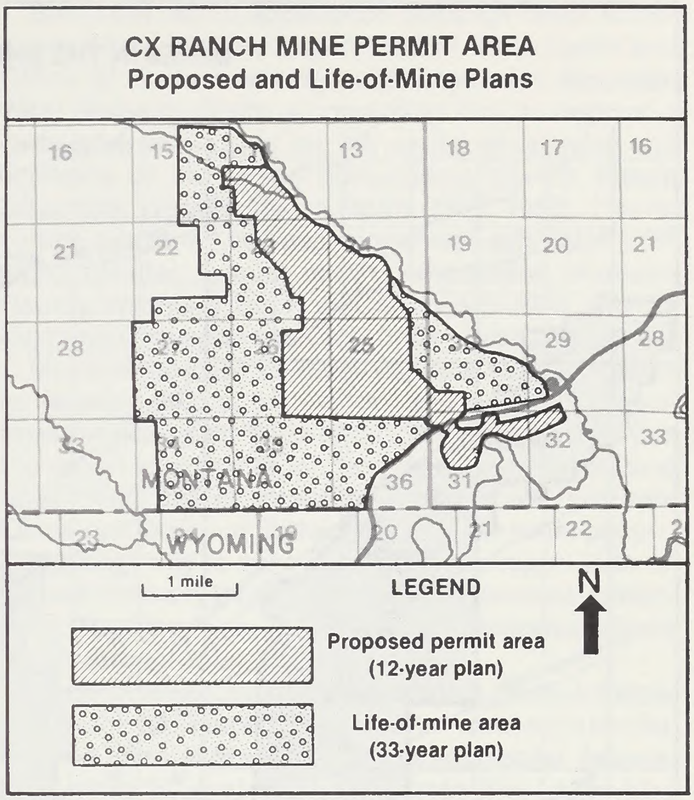
The EIS covers three levels of mine development. Discussed in the greatest detail is Consol's proposed 12-year mine plan (fig. IN-1), for which the most information is available. The 12-year minesite is called the "permit area." (See chapter 1.) Discussed briefly is the company's "life-of-mine" plan (fig. IN-1), a 33-year operation that is likely, though not certain. (The 33-year plan is identical to the 12-year plan for the first nine years.) Also discussed briefly under the socioeconomic topics is the so-called "cumulative scenario."

The cumulative scenario includes the full development of all mines formally proposed in Montana (fig. IN-2.) This scenario, analyzed to show the socioeconomic impacts of the maximum projected growth, assumes that development near Decker, Montana, would include three new mines: CX Ranch, Youngs Creek/Tanner Creek (about 5 miles west of the CX Ranch), and Wolf Mountain (one mile north of the CX Ranch).

The analysis in the EIS is not a prediction of the future. Rather, it is a projection of what would happen if the mine opens and if certain "assumptions" about the future (the 12-year plan, 33-year plan, or cumulative scenario) are correct. Note that the projections are based on the assumptions. An example of an assumption is the mine employment schedule contained in chapter 3, Economics. Another example is the amount of coal mined each year. The projections, based on the most up-to-date data available, are accurate. But the future, as always, is uncertain.

Note that the EIS makes projections of some future impacts not only with new mine development but also without it. That is, chapter 2, Affected Environment, discusses what would happen to employment, income, social conditions, fiscal conditions, outdoor recreation, and social and community services even without new mines. Chapter 3, Impacts, analyzes how the mines would change the level projected in chapter 2.

Note also that there is uncertainty over the 33-year (life-of-mine) plan. The plan cannot go forward until Consol and Chevron Resources Company, joint owners of the CX Ranch Mine, receive additional coal leases. The companies will get these leases under an agreement signed with the Bureau of Land Management (BLM). All of the leases will probably be near Squirrel Creek, next to the coal lease Consol now has for the CX Ranch Mine.


CX RANCH MINE PERMIT AREA
Proposed and Life-of-Mine Plans
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MONTANA
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31
WYOMING
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22
1 mile
LEGEND
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Proposed permit area (12-year plan)
Life-of-mine area (33-year plan)

FIGURE IN-1 Consol has formally submitted a 12-year mine plan. Assuming the company obtains additional coal leases, however, the mine plan would expand to 33 years.

The coal leases Consol and Chevron will receive will come from a lease exchange. The exchange, administered by the Bureau of Land Management, will compensate the companies for coal leases recently "lost." The lost leases include those cancelled on the Northern Cheyenne Reservation and those included in significant alluvial valley floors determined preliminarily by the Department of State Lands as ineligible for mining.

Consol and Chevron have indicated the coal leases they want in the exchange (fig. IN-3). The Bureau of Land Management has written an environmental assessment on the Federal coal exchange (U.S. Department of Interior, 1982), and the agency has proposed that the leases desired by the companies be issued. The leases, when issued, will contain additional stipulations primarily designed to protect lands considered unsuitable for surface mining. Final approval of the lease exchange is pending. Because the life-of-mine plan appears feasible, it is evaluated in the EIS to the extent the available information allows.

PREVIOUS DOCUMENTS AND RESEARCH

The EIS analysis draws data from many sources, each containing the most up-to-date information available. The sources are listed under References Cited at the

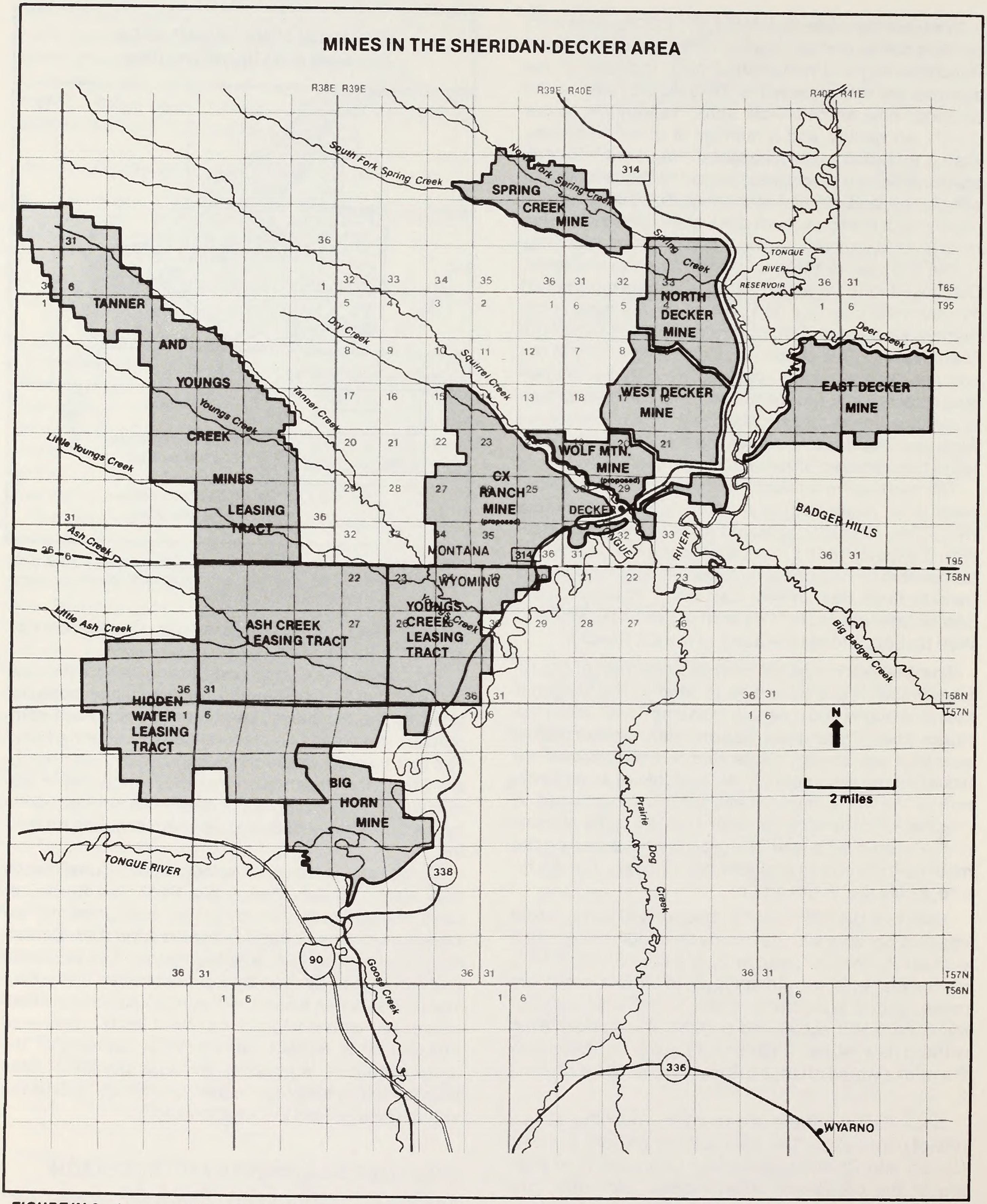
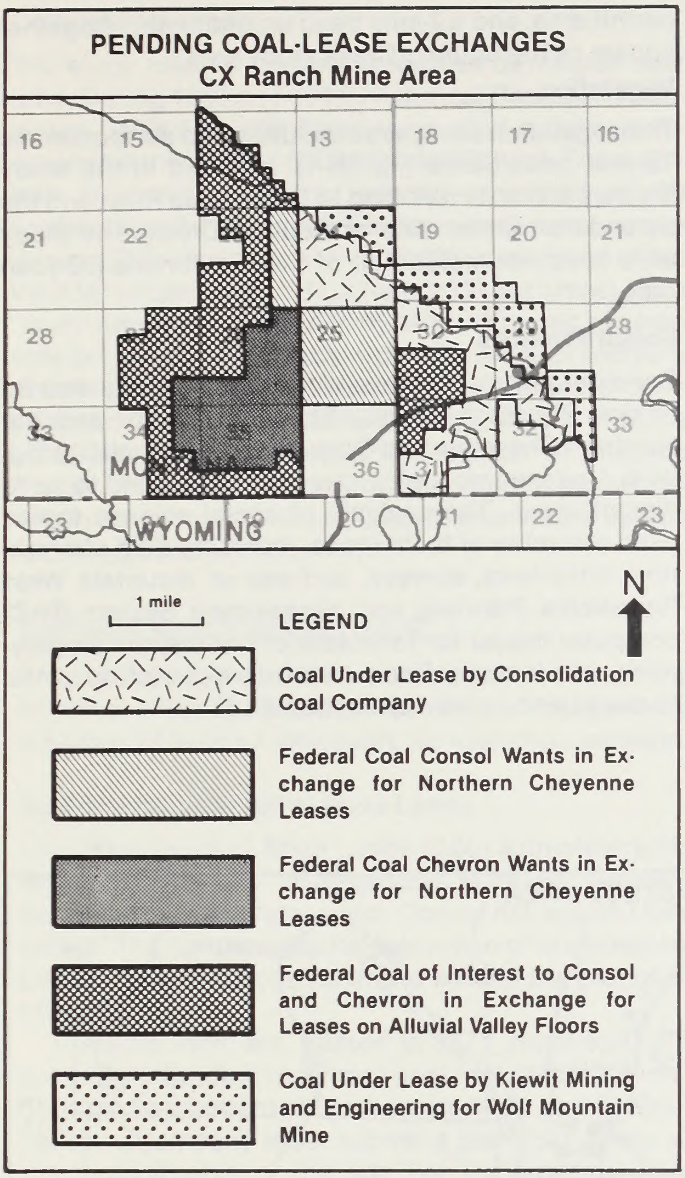


FIGURE IN-2 As many as 11 mines could eventually operate in the Sheridan-Decker area. All 11 are included in the evaluation of cumulative hydrology impacts. Only the mines in Montana and Big Horn Mine in Wyoming are included in the "cumulative scenario" for the socioeconomic topics in the EIS. (Lease information compiled in part from U.S. Department of the Interior, 1984.)


PENDING COAL-LEASE EXCHANGES
CX Ranch Mine Area
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WYOMING
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1 mile
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LEGEND
Coal Under Lease by Consolidation Coal Company
Federal Coal Consol Wants in Exchange for Northern Cheyenne Leases
Federal Coal Chevron Wants in Exchange for Northern Cheyenne Leases
Federal Coal of Interest to Consol and Chevron in Exchange for Leases on Alluvial Valley Floors
Coal Under Lease by Kiewit Mining and Engineering for Wolf Mountain Mine

FIGURE IN-3 Before Consol can expand the mine from a 12- to 33-year operation, the Bureau of Land Management must complete a pending coal-lease exchange. The exchange will compensate Consol and Chevron, joint owners of the CX Ranch Mine, for leases cancelled on the Northern Cheyenne Reservation.

end of the EIS. Some of these documents deserve special mention here.

Of primary importance to the EIS is Consol's application for a mining permit (Consolidation Coal Company, 1984). The application, a 14-volume set, contains detailed, comprehensive data on most of the topics in the EIS. The data, collected over the last three to four years, range broadly, covering such topics as hydrology, soils, coal markets, archeological sites, wildlife, and fisheries. Much of the information found in the EIS comes from information and analyses in the application. For those interested, the application is available for review at the Department of State Lands, Helena and Billings offices, the Office of Surface Mining, Denver, and the Big Horn County courthouse, Hardin, Montana.

Since the permit application does not cover socioeconomic topics, the Department of State Lands and Office of Surface Mining contracted with Mountain West Research-North, a consulting firm, to perform a comprehensive study on the social conditions and economy of the region surrounding the CX Ranch (Mountain West Research-North, 1983, 1985). The resulting report, a 1,600-page document submitted with many smaller special reports, discusses Sheridan County, Wyoming, Big Horn County, Montana, and the Northern Cheyenne and Crow Indian Reservations.

Much of the EIS's coverage of social sciences, such as taxes, schools, population, and housing, comes from the Mountain West report. For those interested, the report is available for review at a number of local government offices, including the Department of State Lands and Office of Surface Mining. For most people, the easiest way to review a copy of the report is to request it from any local library in either Montana or Wyoming. The libraries can obtain the report from the State library through interlibrary loan.

Three other documents that contain much information on the CX Ranch Mine deserve mention: (1) the Bureau of Land Management's Environmental Assessment of the Squirrel Creek Noncompetitive Lease Area (U.S. Department of the Interior, 1982), (2) the Montana Department of Highways report on transportation (Montana Department of Highways, 1983), and (3) the Crow Indian Tribe's report on the Youngs Creek Mine (Crow Tribe of Indians, 1983).

The Bureau of Land Management report, mentioned earlier, describes the CX Ranch lease exchange proposal and gives a preliminary assessment of the mine. Those interested can request a copy from the Bureau of Land Management's Miles City office.

The Department of Highways' report describes the principal routes from Sheridan to the mine, listing traffic levels, safety hazards, and estimating future traffic levels and needed improvements. The report also examines the access to the mine, effects of mine-related traffic, and the likely effect of the over-the-road conveyor proposed by Consol. The report can be reviewed at the Department of State Lands, Helena.

The report by the Crow Tribe primarily addresses the impacts expected from Youngs Creek Mine, which would operate on the reservation. Within the report's cumulative scenario, the tribe looks at the effects of the CX Ranch Mine. The Crow Tribe's report can be reviewed at both the Department of State Lands, Helena, and the Office of Surface Mining, Denver.

METHODS AND STUDY AREAS

An understanding of the methods used and precise lands studied helps in understanding some of the topics in the EIS.

Hydrology

The analysis of hydrology covers three study areas, matching the three levels of mine development. The proposed 12-year plan study area includes the minesite and a 2-mile-wide band around it. The life-of-mine study area includes the 33-year area, a 2-mile-wide band around it, and the Tongue River. The cumulative study area, about 150 miles square, includes the Tongue River and the lands covered by all existing and proposed mines nearby—West Decker (existing), Big Horn (existing, North Decker (existing), Spring Creek (existing), East Decker (existing), CX Ranch (proposed), Wolf Mountain (proposed), Tanner and Youngs Creek (possible), Youngs Creek (possible), Hidden Water (possible), and Ash Creek (possible) (fig. IN-2).

Wildlife

Like hydrology, wildlife has three study areas. The smallest includes the 12-year permit area. The next includes the life-of-mine area. And the third includes the life-of-mine area, the Wolf Mountain Mine proposed permit area, and a 2-mile band around both, altogether known as the Squirrel Creek study area.

Vegetation

The vegetation study area includes and surrounds the 12-year permit area (fig. IN-1). Included in the study area are all lands reaching to the Tongue River and the uplands on either side of Squirrel Creek. The study area does not include all of the life-of-mine (33-year) area.

Social Sciences

For most purposes, the social sciences study area includes Big Horn County, Sheridan County, and the Northern Cheyenne and Crow Indian Reservations (fig. IN-4). Under some topics, descriptions extend to more distant areas. The analysis of social science topics used a number of techniques, including field observation, interviews, surveys, and use of Mountain West Research's Planning and Assessment System (PAS) computer model for forecasts of population, employment, and income. For a complete description of the social science study, see appendix A.

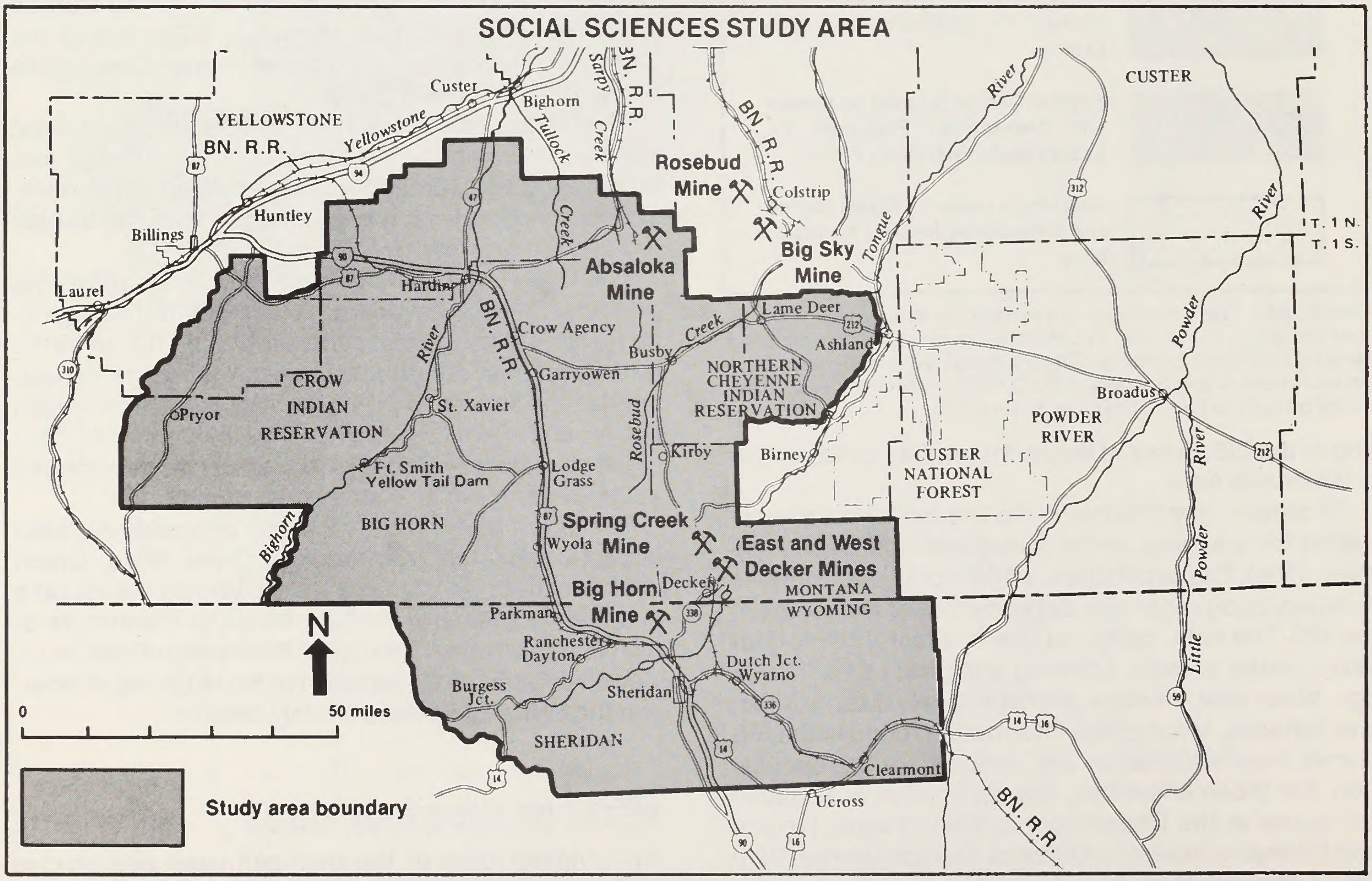


FIGURE 1N-4 Socioeconomic topics in chapter 2 and 3 of the EIS primarily cover Big Horn County, Sheridan County, the Crow Reservation, and the Northern Cheyenne Reservation.

Cultural Resources

The study area for cultural resources developed over time. During 1980 and 1981, Historical Research Associates, Missoula, Montana, conducted a cultural resources survey of the CX Ranch for Consol. The methods in conducting the survey consisted of (1) preparation of a pre-survey literature review and survey design; (2) intensive survey of 10,000 acres (most of the Wolf Mountain Mine and CX Ranch 33-year areas) and a "reconnaissance-level" survey of 12,420 acres in a one-mile buffer zone around the intensive area; (3) analysis, documentation and evaluation of all cultural properties; and (4) recommendations for the listing of some cultural sites in the National Register of Historic Places. Mitigation plans for all eligible properties within the proposed 12-year permit area were prepared following the analysis.

AGENCY RESPONSIBILITIES

A number of agencies have participated in the writing or review of the EIS and a number will participate in the issuance of permits necessary for a mining operation.

Montana Department of State Lands

The Department of State Lands (DSL) administers the Montana Strip and Underground Mine Reclamation Act (82-4-2, MCA), under which Consol has applied for a permit. The act provides for protection of environmental and cultural resources in and around the proposed minesite.

The strip mine act, passed in 1973, requires that a company intending to remove coal first obtain a permit from the Department of State Lands. In its permit application, a company must submit a plan that meets all the requirements of the act. For instance, the plan must show that the company will salvage and replace all topsoil; restore the mined land to the approximate premining contour; plant a permanent and diverse cover of vegetation composed of predominantly native species; protect alluvial valley floors; and preserve the hydrologic functions (such as subirrigation) of valleys.

Typically, after receipt of an application, DSL issues a "deficiency" letter. The letter points out to the company the parts of the mine plan that do not comply with the law. The company then changes and resubmits the plan. Through meetings and the use of deficiency letters the mine plan is continually improved. When the plan has adequately addressed all provisions of the law, DSL makes its decision.

Office of Surface Mining

In 1977 Congress passed the Surface Mining Control and Reclamation Act (SMCRA). The Department of the Interior, Office of Surface Mining, administers the act. Under SMCRA, DSL developed a "permanent regulatory program," which delegated to DSL on April 1, 1980, the responsibility for regulating mining on private lands. Through a cooperative agreement, OSM then delegated its regulatory authority to DSL for Federal lands.

Although the Department of the Interior has thus delegated its regulatory authority, it cannot, under SMCRA or the Mineral Leasing Act, delegate its responsibility to approve mining plans, carry out the provisions of the National Environmental Policy Act, or to comply with other laws, regulations, and executive orders pertaining to coal mining. Moreover, even though DSL is now the main agency regulating coal mining in Montana, OSM oversees DSL's work to be sure the regulatory program complies with SMCRA. As part of its responsibility under the National Environmental Policy Act, OSM is jointly preparing this EIS with DSL.

Bureau of Land Management

The Bureau of Land Management is responsible for the postmining land use of Federal land, Federal coal lease exchanges, and actions taken under the Mineral Leasing Act. At the CX Ranch, the Bureau has been responsible for processing the pending coal lease exchange and has assisted the agencies in preparing the EIS.

Montana Department of Health and Environmental Sciences

Consol has applied to the Air Quality Bureau of the Department of Health and Environmental Sciences for an air quality permit, which is necessary before the company can begin operations. Prior to receiving the permit, Consol must demonstrate that mining would violate neither the Montana nor the Federal Clean Air acts.

Consol must also file with the Water Quality Bureau for a Montana Pollutant Discharge Elimination System (MPDES) permit. The permit would cover surface water discharges from pits and ponds and sanitary wastewater discharges from the entire CX Ranch Mine. Discharges have to meet effluent limitations and water quality standards established by the Montana Board of Health and Environmental Sciences.

State Historic Preservation Office

The State Historic Preservation Office has the responsibility to cooperate with and advise the Department of State Lands when potentially valuable historical, archaeological, or other cultural resources are located in a project site (Montana Strip and Underground Mine Reclamation Act [82-4-201 through 82-4-228, MCA], the Montana Antiquities Act [22-3-401 through 22-3-442, MCA], and the National Historical Preservation Act [P.L. 89-665 as amended and reauthorized E.O. 11593]). The office seeks a determination from the Keeper of the National Register for sites believed to be eligible for listing on the National Register of Historic Places. The office comments on a company's plan for impact mitigation of sites eligible for nomination to the National Register of Historic Places. The office also reviews the EIS to ensure compliance with cultural resource regulations. During mine operation, the Department of State Lands is responsible for monitoring compliance with historic preservation and monitoring plans.

U.S. Fish and Wildlife Service

The U.S. Fish and Wildlife Service administers the Endangered Species Act, as reauthorized in 1982, and the Bald Eagle Protection Act of 1940 (as amended). Since the CX Ranch Mine may affect threatened or endangered species, OSM must prepare a biological assessment to comply with the Endangered Species Act. If the assessment determines impacts would adversely affect threatened or endangered species, OSM must consult with the Fish and Wildlife Service to determine measures to protect the affected species.

ADMINISTRATIVE ALTERNATIVES

The Department of State Lands and the Department of the Interior have analyzed and must select one of five administrative alternatives.

Approve the Application as Proposed

The environmental effects of approving the mining and reclamation plan as proposed are contained in chapter 3. (Note that although the agencies consider Consol's 12-year plan when reviewing the permit application, the company still has to renew the permit every 5 years, even if the mining plans do not change. Mining permits are issued for 5-year terms only.)

No Action

The Department of the Interior has considered the possibility of no action. But no action has been determined unreasonable, since Consol has fulfilled the requirements of its Federal lease and has filed a complete permit application with the Office of Surface Mining. The law requires the Secretary of the Interior to make a decision on whether to approve the mining plan and issue a Federal permit to mine coal. For the purposes of the EIS, no action would be the same as rejecting the application. Therefore, no action is not considered further as a separate alternative.

Reject the Application

The agencies may reject an application that does not meet the requirements of the permanent regulatory program (ARM 26.4.301 et seq.). The effects of rejecting the application would be that the affected environment would remain as described in chapter 2.

Selectively Reject the Application

The agencies can reject approval for mining specified areas. The specified areas would include, for example, those having special, exceptional, critical, or unique characteristics, or where mining would affect the use, enjoyment, or fundamental character of neighboring land having these special characteristics. The specified areas could also include those that could not meet State and Federal reclamation standards.

DSL and OSM have not at this time identified any lands for selective rejection, but that does not preclude such action following review of this draft EIS. The public is invited to comment on this alternative and if such areas are identified, they will be analyzed in the final EIS.

Approve the Application with Special Conditions (Preferred Alternative)

If parts of the proposed 12-year plan were considered unacceptable, the agencies could approve mining with special conditions. Modifications identified in this EIS that would reduce the impacts of the mine are listed as separate sections at the end of each subject in chapter 3. These sections are titled "Mitigating Measures." The agencies have not chosen any specific conditions from those mitigating measures identified. The public is invited to comment on the special conditions that should be required.

COMPARISON OF ALTERNATIVES CONSIDERED

The Department of State Lands and the Department of the Interior are now considering three alternatives: approve the application as submitted, reject the application, or approve the application with special conditions. Approving the application as submitted would allow Consol to proceed with its proposed 12-year plan. In this plan, the mine would—

- Remove three wells and lower the water quality or water levels in six other wells.
- Increase total dissolved solids in shallow ground water by 50 percent, to 2,100 mg/l.
- Raise ammonia concentrations in Squirrel Creek by 200 to 300 percent and in the Tongue River under extreme conditions by 30 percent.
- Occasionally kill fish in Squirrel Creek and eliminate a potential spawning habitat at the creek's mouth as a result of increased ammonia concentrations.
- Reduce soil quality in the short term by eliminating the natural profile and pore space continuity, breaking down soil structure, and reducing pore space and organic matter content.

- Eliminate most seed, plant parts, and microorganisms important to nutrient cycling in soils that are stored for prolonged periods.
- Temporarily eliminate 974 acres of wildlife habitat, particularly 150 acres of pronghorn winter range, 3 raptor nest sites, and a sage grouse wintering area.
- Add as many as 2,700 people to the Sheridan County population and 140 people to the Big Horn County population.
- Raise the demand for teachers in Sheridan County.
- Aggravate today's fiscal imbalance between Montana and Wyoming, increasing public spending mostly in Wyoming while increasing the tax base mostly in Montana.
- Increase traffic on Wyoming 338/FAS 314 by as much as 455 vehicle trips per day.
- Eliminate the potential production of 90 head of cattle, owing to the temporary suspension of agriculture on 974 acres.
- Cause conversion of 350 acres of land in Sheridan County to urban and rural residential uses.
- Destroy or damage 6 prehistoric cultural sites potentially eligible for listing on the National Register of Historic Places.

Approval of the application with special conditions would have many of these same impacts. However, to the extent that special conditions are imposed, the impacts would be reduced.

Application rejection would eliminate the detrimental impacts of application approval. But rejection would also mean the loss of the potential for—

- The creation of as many as 604 mine jobs and another 1,181 jobs resulting from population growth.
- The addition of $34.2 million to Sheridan County personal income, an increase of 8.6 percent over the level expected if no mining takes place.
- The payment of about $500 million in Federal, Montana, and Big Horn County taxes, resulting in part from a $79 million increase in the tax base of Big Horn County.

TECHNICAL AND ENERGY ALTERNATIVES

Technical Alternatives

The Department of State Lands and the Department of the Interior have also considered alternative ways of mining the coal at the CX Ranch Mine, but other methods are either impractical or inferior to the proposed truck-and-shovel strip-mining operation proposed by Consol. As a result, no alternative mining methods have been analyzed in detail in this EIS. Alternative mining methods considered but rejected include auger mining, underground mining, and dragline mining.

Although practiced in nearby mines, dragline mining would have two drawbacks at the CX Ranch. First, operating the dragline efficiently would be difficult, because in places the topography is rolling and dissected and the location of the coal seams variable. This is especially true in the life-of-mine area. Second, the dragline cannot easily handle overburden selectively. Consol's plan of separately storing the favorable overburden—to promote plant growth during reclamation—would be difficult or impossible.

Underground mining has several disadvantages. Although an underground method would not disturb the soil and rock strata overlying the coal, the land surface could subside after mining, as the underground mine workings collapsed. The resulting depressions and holes would limit land use for livestock grazing. A further problem might be underground coal fires, which can start where unmined coal is exposed to air. Such fires have burned for years, despite repeated efforts to extinguish them. Underground mining also recovers considerably less coal than strip mining: The most efficient techniques recover about 80 percent, compared to the 93 percent Consol expects to recover using the truck-and-shovel method.

Auger mining could be used in conjunction with strip mining to recover additional coal in highwalls and along outcrops. In highwalls, for example, the auger could bore into the coal seams beyond the economic limit of overburden removal for coal stripping. Auger mining, in this case, would not replace strip mining, but would be used as a minor supplement to the strip-mining methods already proposed.

Auger mining, like underground mining, has two drawbacks. The holes left by the auger would be costly and difficult to seal. In addition, the company would recover less than 50 percent of the coal, leaving the remaining coal unrecoverable by conventional techniques.

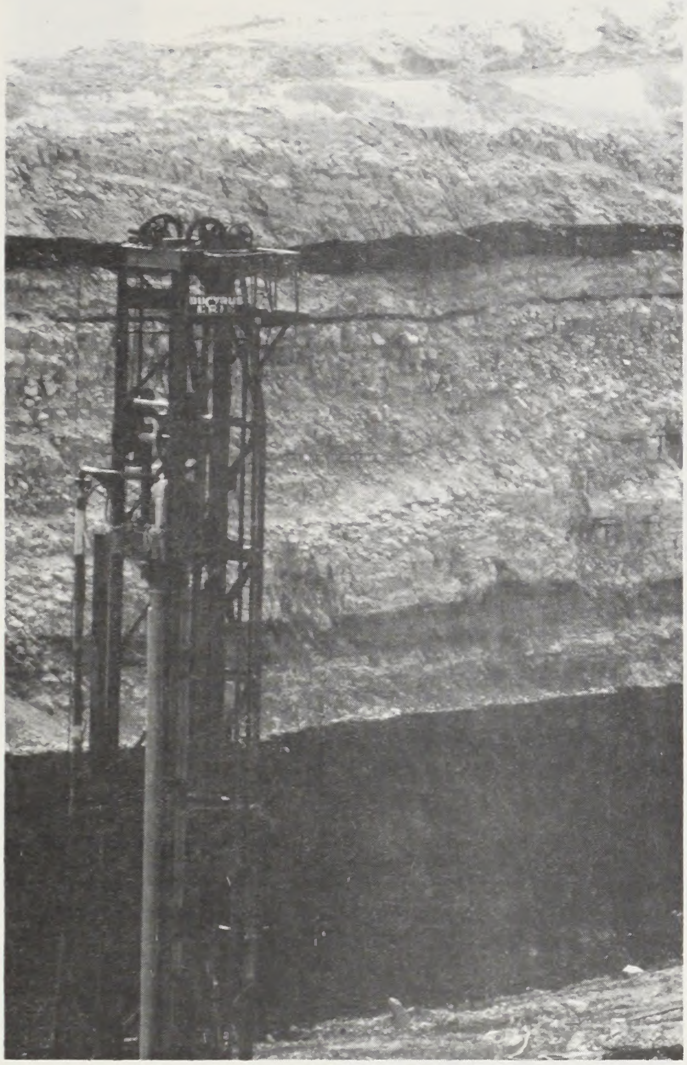
Construction Alternative

One alternative method of laying out the mine was considered: putting the entire railroad loop on the north, rather than the south, side of the Decker highway. (See chapter 1.) This would prevent the loop from disturbing 14.1 acres of prime farmland soils. But this alternative, like other mining methods, was ruled out.

The alternative was primarily dropped because of two disadvantages: It would require more, costly earthmoving. It would also require the construction of an underpass on the Decker highway. If an underpass were not constructed, a crossing would have to be installed. The risk of train collisions with cars would then increase, since all Decker area mine traffic would pass the CX Ranch Mine.

The alternative was also dropped because it offered no major advantage. The Department of State Lands has determined that the loss of the prime farmland acreage would be insignificant to overall production at the Foss Ranch, user of the land (Consolidation Coal Company, 1984, vol. 6).

In the end, the railroad loop was proposed on the south side of the highway because no other location would work as well. Movement of the loop to the west was blocked by private land, to the south by the Tongue River floodplain, to the east by the need to keep the loop near the mine, and to the north by the disadvantages of moving across the Decker highway.



Chapter

1

CONSOLIDATION COAL COMPANY'S PROPOSAL

Consolidation Coal Company's mine would lie in Big Horn County, Montana (fig. 1-1), 2 miles west of Decker, Montana, and 22 miles north of Sheridan, Wyoming. (See location map in Summary.) The company, known as Consol, is a wholly owned subsidiary of Conoco Inc. (a wholly owned subsidiary of E.I. Du Pont De Nemours and Company). Mine plans call for the excavation of 46.9 million tons of coal over 12 years.

Should Consol acquire additional coal leases next to the mine, the company's net minable reserves would rise by sixfold. The life of the mine would then increase, probably by 21 years (to 33 total), and perhaps more. The minesite would expand considerably to the south and west (fig. 1-2).

The proposed mine would lie along the lower reaches of Squirrel Creek, just northwest of the Tongue River. The 12-year permit area, which straddles the Decker highway (FAS 314), would cover 1,905 acres, including all or part of sections 14, 15, 23, 24, 25, 26 of T9S, R39E, MPM, and sections 29, 30, 31 of T9S, R40E, MPM.

The company plans to begin construction of the mine in 1988. Coal production would begin in 1990 and would last 7 years, peaking in year 5 at 8 million tons per year.

Over the 12-year life of the mine, the company would disturb 974 acres—429 acres for mining, 277 acres for

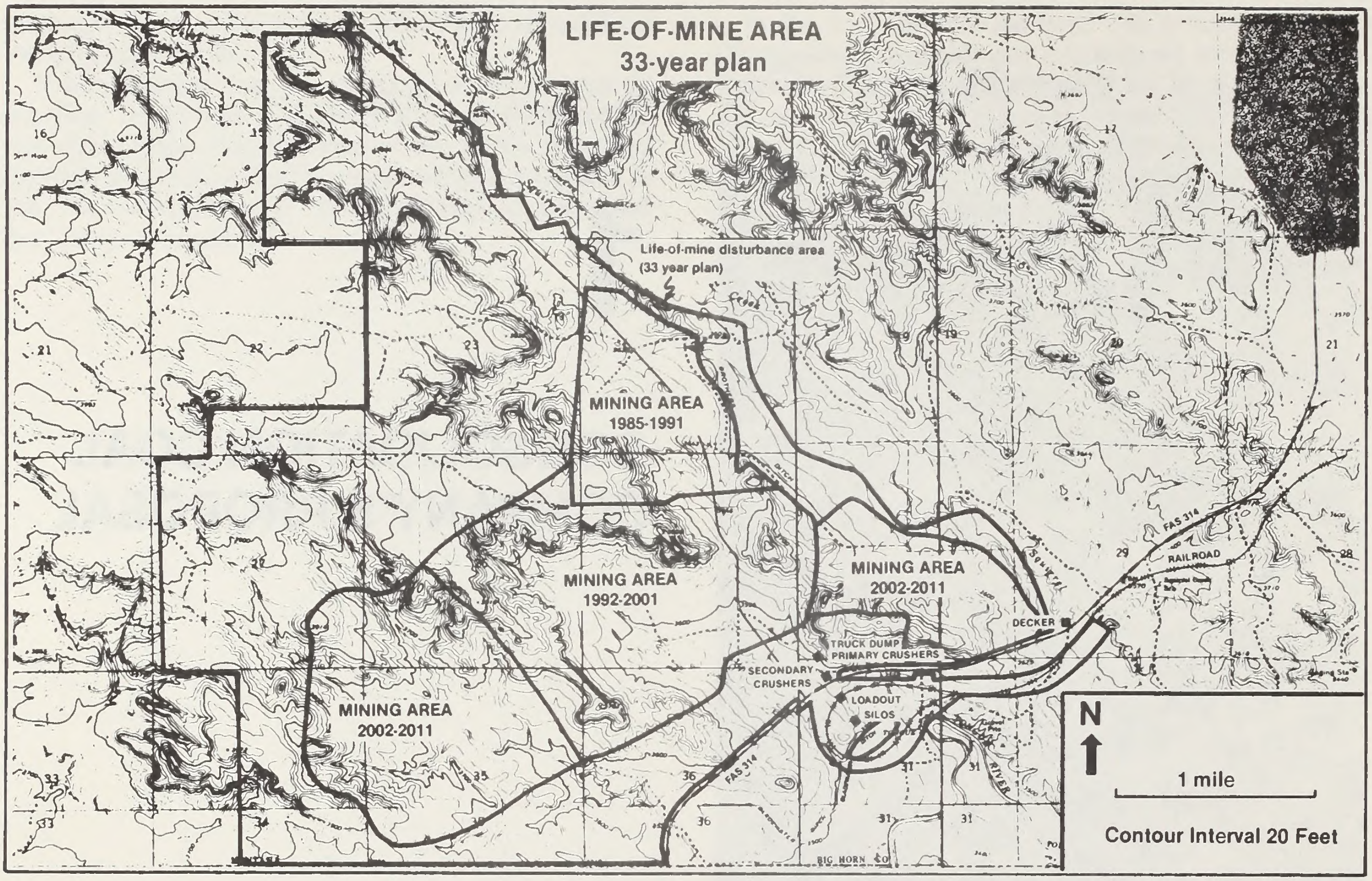


FIGURE 1-2 The long-range (33-year) plan calls for extending the mine pit southwest and southeast. The total permit area would increase to 5,625 acres and the mine pit to 2,429 acres. Coal production could reach as high as 16 million tons per year.

overburden stockpiles, 74 acres for topsoil stockpiles, 53 acres for mine facilities, 38 acres for haul roads, 52 acres for the rail loop and spur, and 51 acres for sediment ponds and ditches. These 974 acres are called the "disturbance area."

Should the life of the mine extend to 33 years, coal production could reach 16 million tons per year. The company would expand the permit area by 3,720 acres and disturb about 2,000 more acres for mining. Over the life of the mine, 332 million tons of coal would be excavated.

The law requires Consol to submit to the Department of State Lands a bond sufficient to cover the total cost of minesite reclamation. Consol proposes to adjust the amount of the bond each year. For year 1, before coal excavation, the company would bond 290 acres for mining-level disturbance, 245 acres for facility-level disturbance, and 1,370 acres for associated disturbance. (Mining-level disturbance includes mining and overburden stockpiles; facility-level disturbance includes haul roads, sediment ponds, the railroad line and siding, and mine facilities; and associated disturbance includes access roads, topsoil stockpiles, ditches, fences, and other minor disturbances.) As mining progresses, Consol would gradually redesignate associated-disturbance lands as

CX Ranch Coal Reserves

Five coal seams underlie the Consol 12-year permit area. From top to bottom these include the Smith 1, Smith 2, Anderson-Dietz (a combination of the Anderson, Dietz 1, and Dietz 2), Canyon, and Wall. Consol would mine only the upper four seams, since the Wall is too deep to be mined economically.

The Smith 1 and Smith 2 seams are thin and discontinuous. Of primary significance to Consol are the next two lower seams—the Anderson-Dietz and the Canyon. The Anderson-Dietz, covered in the minesite by an average of 320 feet of overburden, averages 80 feet in thickness. The Canyon seam, an average of 80 feet below the Anderson-Dietz, averages 21 feet in thickness. The Anderson-Dietz overburden is shallowest, about 200 feet, at the northern end of the 12-year pit, where Consol would begin mining. The cover increases to over 450 feet at the southern end of the pit. The thickness of the interburden (the material between coal seams) remains about the same throughout the proposed minesite.

Consol would mine every seam encountered, recovering the maximum percentage possible with current

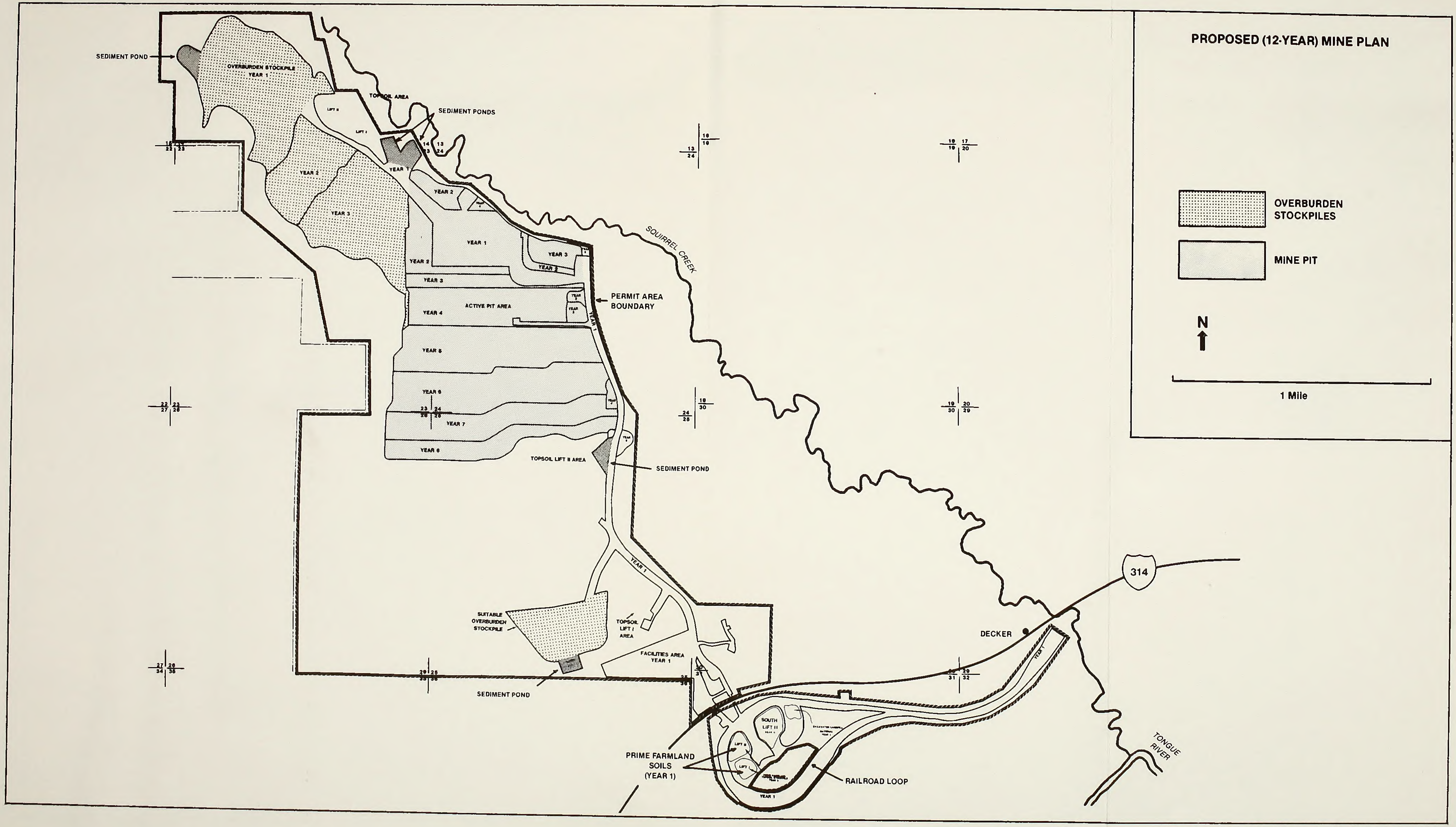


FIGURE 1-1 Mine plans call for the permit area to be developed over 12 years. The mine pit would be kept all in the same place; the overburden stockpiles, which would store the unwanted rock stripped from above the coal, would be built in two places.

technology. The company estimates that about 7 percent of the 50.4 millions tons of reserves would be lost to spillage, regulatory constraints, and limits on coal extraction technology.

Although Consol now has no contracts for sale of its coal, the company intends to center its marketing efforts on utilities that run coal-fired electric generating plants. The quality of the coal in the Anderson-Dietz and Canyon seams is shown in table 1-1.

TABLE 1-1
Coal Quality

	Coal Seam	
Measure	Anderson-Dietz	Canyon
BTU per pound	9,600	9,300
BTU per pound (dry)	12,402	12,510
Ash-free BTU	13,064	13,106
Percent moisture	21.19	21.06
Percent ash	5.06	4.54
Percent sulfur	0.38	0.43
Slagging type	Low	Low
Fouling type	Severe	Severe

Sources: Consolidation Coal Company, 1984, vol. 5; Earl Smith, Consolidation Coal Company, pers. com., February 26, 1985.

Note: The Smith seams are not included because comparable data are unavailable.

Consol owns all the lands in the CX Ranch 12-year permit area (fig. 1-3). All coal proposed for mining in the 12-year plan is owned by the Federal government. The coal for which Consol now has leases is shown in figure 1-4. (Note that the pit would extend beyond the limits of Consol's coal leases [fig. 1-1], owing to the stair-step pit benches that Consol must excavate to reach the coal.)

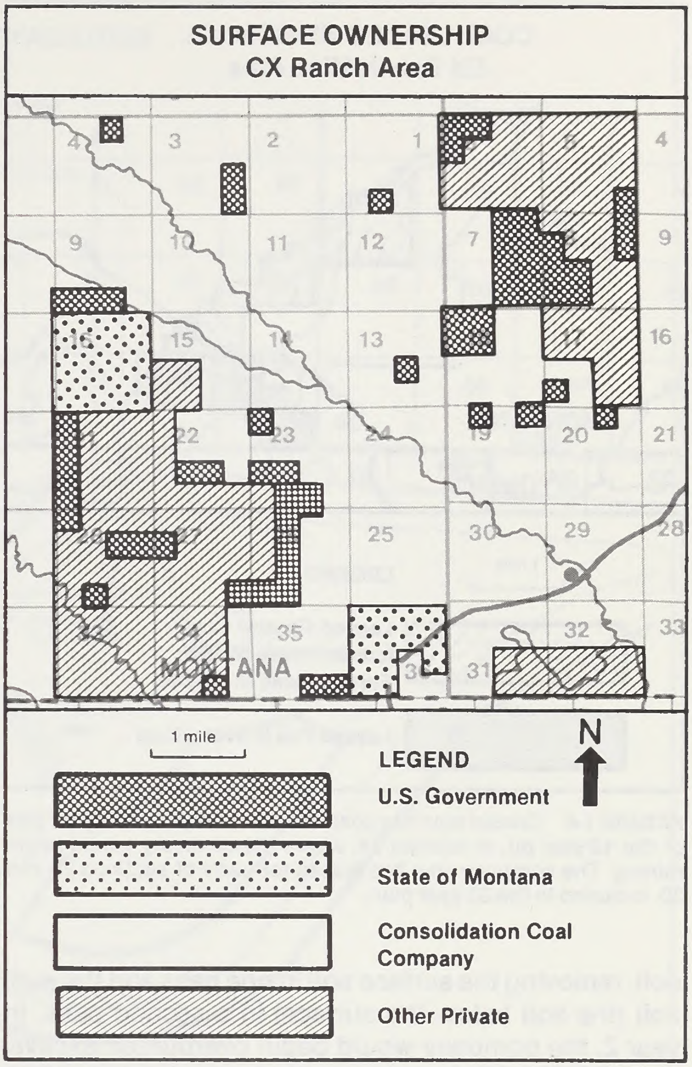


FIGURE 1-3 Consolidation Coal Company owns the surface of the entire CX Ranch, which covers 25,000 acres (extending northwest into the Crow Reservation). Other private landowners nearby primarily include other energy companies.

Construction of the Mine Facilities

The construction of the mine, including sediment control structures, support structures, coal-processing structures, roads, and the railroad loop, would take up much of the first two years of Consol's operation.

Support facilities to be constructed at the mine would include a shop, changehouse, warehouse, office complex, tire shop, gas island, bathhouse, parking area, sewage system, and analytical laboratory (fig. 1-5). The Sheridan-Johnson Electrification Cooperative would provide power to the site via a 115-kilovolt transmission line. To distribute the power, Consol would build several substations within the mine.

Coal-processing facilities to be built during the first two years of the operation include a coal dump station, primary crusher, secondary crusher, coal loadout, storage silos, several conveyors, and other minor structures (fig. 1-5). Coal would first reach the processing facilities at the dump station, equipped with bins into which trucks would dump the coal. The conveyors would carry the coal from the bins to the primary and secondary crushers, which would break the coal into pieces not greater than 2 inches in the maximum dimension. From the secondary crusher, an aerial conveyor would carry the coal over the Decker highway (FAS 314) to either the train loadout, for direct loading into unit trains, or to the storage silos.

Consol would also build the mine roads and railroad during the first two years of operation. The roads would link the topsoil stockpiles, overburden stockpiles, the mine pit, the facilities complex, and the Decker highway. The railroad that would serve the mine would branch from the Decker spur, which passes within three miles of the minesite. At the southern end of the mine, alongside the Decker highway, Consol would build a rail loop where trains would load and turn around (fig. 1-5).

Mining the Coal

Consol would begin mining each part of the pit by stripping the topsoil. Scrapers would take all salvageable

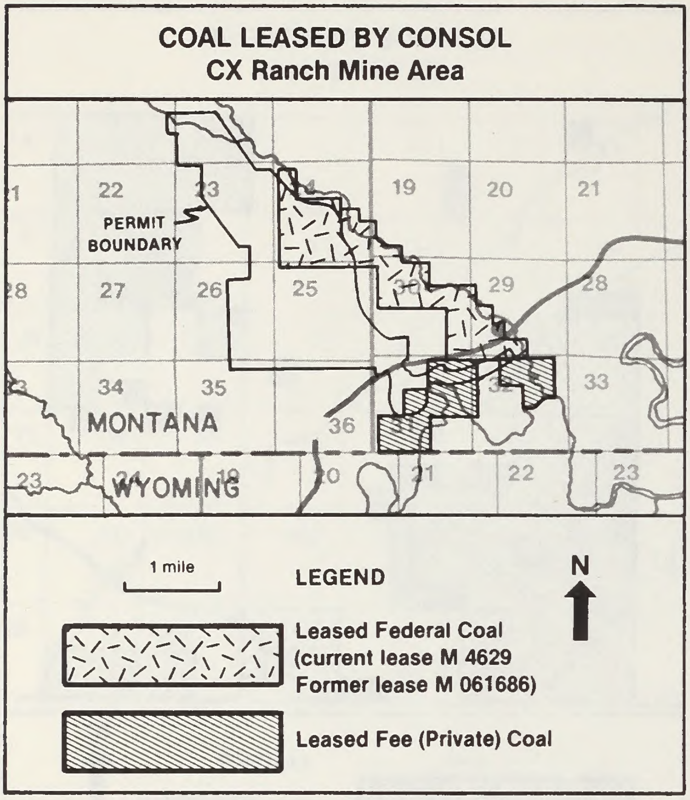

COAL LEASED BY CONSOL
CX Ranch Mine Area
PERMIT BOUNDARY
MONTANA
WYOMING
1 mile
N
LEGEND
Leased Federal Coal (current lease M 4629 Former lease M 061686)
Leased Fee (Private) Coal

FIGURE 1-4 Consol now has coal leases for only the northern part of the 12-year pit, in section 24, where the company would begin mining. The company also has leases for parts of sections 29 and 30, included in the 33-year plan.

soil, removing the surface soil in one pass and the subsoil (the soil below the surface) in a second pass. In year 2, the company would begin overburden excavation. Rotary drills would bore holes into the overburden, and the holes would be loaded with ammonium-nitrate/fuel-oil (ANFO) explosives. The company would then detonate the charges to fracture the overburden, and electric-powered shovels would load the material into 170-ton dump trucks.

Coal removal, starting in year 3, would follow overburden removal. The company would first blast the coal strata. Then shovels would load the broken coal into 170-ton bottom-dump trucks. The trucks would carry the coal out of the pit and drop it into bins at the dump station.

The first coal seam extracted from most of the pit would be the Anderson-Dietz. To get to the next seam, the company would excavate the underlying material, or interburden, lying over the Canyon seam. The company would then extract the Canyon coal.

Throughout the operation, Consol would segregate surface soil and subsoil. Initially, the soil would be stored in stockpiles. Later, the scrapers would haul the soil directly from ongoing excavations to parts of the pit already mined. Scrapers would respread the soil where the pit has been refilled with overburden and the surface regraded.

The company would also segregate "suitable" and "unsuitable" overburden. The suitable overburden would be material that, after field testing, proved favorable as a plant growth medium. The unsuitable material would be overburden determined to be too high in sodium, salts, or other constituents to promote healthy plant growth. Initially, as with soil, the company would haul the overburden to different stockpiles. Later, when possible, the trucks would dump directly into the empty (mined-out) parts of the pit. Figures 1-1 and 1-2 show the areas that Consol proposes to excavate each year and the location of the soil and overburden stockpiles.

Throughout the mine's life, Consol would route all surface water draining from lands disturbed by mining to sediment ponds. Consol would build sediment ditches to collect runoff from spoil, soil stockpiles, and other disturbed land. The ditches would direct the runoff to one of 18 ponds, each capable of completely containing all runoff from the 10-year, 24-hour precipitation event. At the ponds, suspended sediment would settle out of the water. Within 15 days the water could be released, if it meets requirements established by the Department of Health and Environmental Sciences.

Employment at the Mine

The company would hire about 600 people to construct and operate the proposed 12-year mine and facilities. In the 33-year plan, 940 would be hired. The operation would run year-round, 24 hours a day.

Reclamation—Backfilling Overburden and Spreading Soil

Once Consol removes the Canyon coal, pit backfilling would begin. The source of backfill would depend on when it was needed. During the first years of backfilling, the company would haul overburden directly from ongoing excavations to the mined-out pit. Later, near the end of the mine's life, the company would retrieve overburden from stockpiles for the backfill.

Consol plans two special overburden-handling steps. First, the company proposes to backfill the bottom of the pit with Canyon-Dietz interburden. This would reestablish the Canyon aquifer with favorable material. Second, the company would place all unsuitable overburden at least eight feet below the surface. The top eight feet—the rootzone—would be reserved for suitable material.

After the pit is filled, dozers would grade the overburden to about the original topography (figs. 1-6 and 1-7). Postmining slopes would not exceed 5:1 (20 percent), except for those rising steeply to match adjacent, unmined topography. Drainages and channels would be

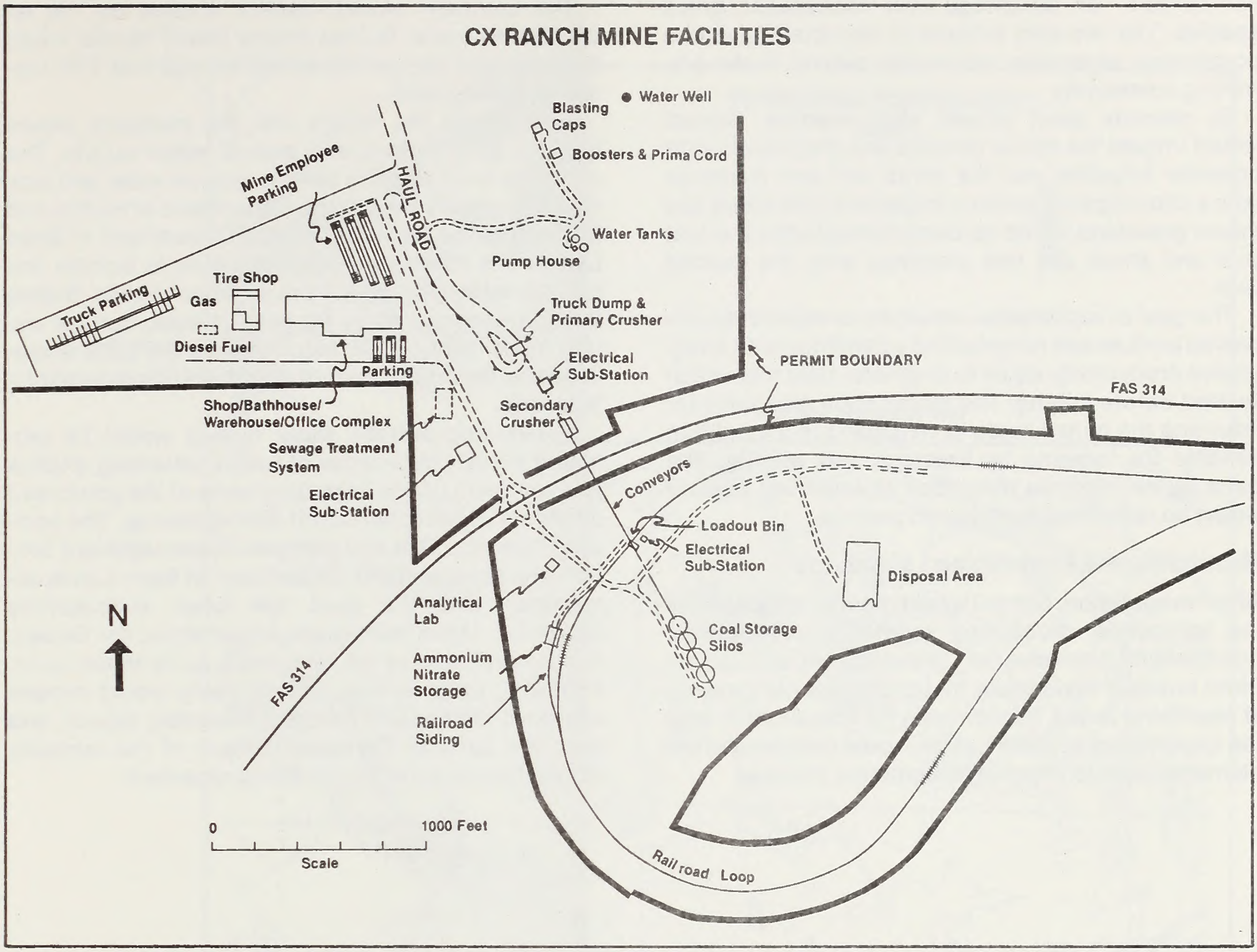


FIGURE 1-5 The facilities would straddle the highway (FAS 314). On the north side, Consol would build the repair, maintenance, and administrative buildings. On the south side, the company would build the railroad loop and coal-loading station.

shaped to match (approximately) their premining shape. Postmining channel gradients would be the same as before mining, and the channels would be constructed to have smooth, stable transitions from mined to unmined sections.

While grading, dozers would move along the contour, to minimize erosion and create a surface that would prevent topsoil slippage. To further prevent soil slippage and promote root and water penetration between the soil and overburden, Consol would scarify (break up) all regraded surfaces before spreading the soil.

After grading and scarifying, scrapers would lay down soil to a uniform thickness, spreading an average of 22 inches of subsoil followed by 4 inches of topsoil. Where soil testing shows nutrient deficiencies, the company would apply fertilizer according to a plan approved by the Department of State Lands.

Reclamation—Planting the Vegetative Cover

Consol would disk and chisel plow the soil surface to break up compacted areas, trap moisture, and prepare the soil for seeding. Seeding would take place no more than 90 days following soil replacement. The company would spread seed in two steps, using either native plant species or drought-tolerant introduced species approved by the Department of State Lands.

In the first step, Consol would broadcast seed the minesite with forbs, shrubs, and warm-season grasses. To minimize erosion during initial plant growth, the company would include wintergraze (a temporary cover crop for protecting the soil) in the seed mixture and would mulch the surface with straw or native hay. Over the next two years, the company would plant shrubs and trees using both containerized stock and transplants from nearby areas.

The second seeding step would follow two years after the first. The company would then merely drill seed cool-season grasses among the plants established during the first seeding step.

The purpose of two-step seeding is to give forbs, shrubs, and warm-season grasses—relatively poor competitors—an advantage over cool-season grass species. The two-step process is expected to yield a postmining vegetative community similar to the premining community.

To promote plant growth after seeding, Consol would irrigate the mixed grasses and shrublands with sprinkler irrigation and the shrub and tree plantings with a drip-irrigation system. Irrigation of the shrub and mixed grassland would be discontinued after the first year and shrub and tree plantings after the second year.

The goal of reclamation would be to restore the improved pasture and rangeland to a condition with a vegetative productivity equal to or greater than that which existed before mining. The reclamation plan calls for returning the mined lands to rangeland in a condition suitable for foraging by livestock and wildlife. The parts of the minesite now used as improved pasture would be reclaimed to improved pasture.

Monitoring the Postmining Landscape

After revegetation, Consol would monitor the postmining landscape, measuring vegetative productivity, plant density, plant diversity, ground cover, and soil nutrient levels. If tests show that plants are not growing at premining levels, the company (in consultation with the Department of State Lands) would prepare and implement a plan to improve revegetation success.

The company would monitor erosion on the reclaimed minesite. Gullies deeper than 9 inches would be tilled, and the surface would be respread with topsoil and reseeded.

Throughout the mine's life, the company would monitor both surface and ground water quality. The company is required to sample ground water and provide test results to both the Department of Health and Environmental Sciences and the Department of State Lands. The company would also have to sample any surface water discharge from sediment ponds. Before the company can apply for bond release, surface waters must meet permit requirements (MPDES) established by the Department of Health and Environmental Sciences.

Postmining surface water quality would be protected initially by a series of runoff collecting ditches and sediment ponds (including some of the ponds and ditches that collected runoff during mining). The company must monitor and maintain these sediment control structures until the Department of State Lands determines that the land has been successfully reclaimed. Upon successful reclamation, the Department would release the company's reclamation bond. Following bond release, the company would remove sediment ditches and ponds and regrade, topsoil, and seed the surface. Complete control of the minesite would then revert to the ranch management.

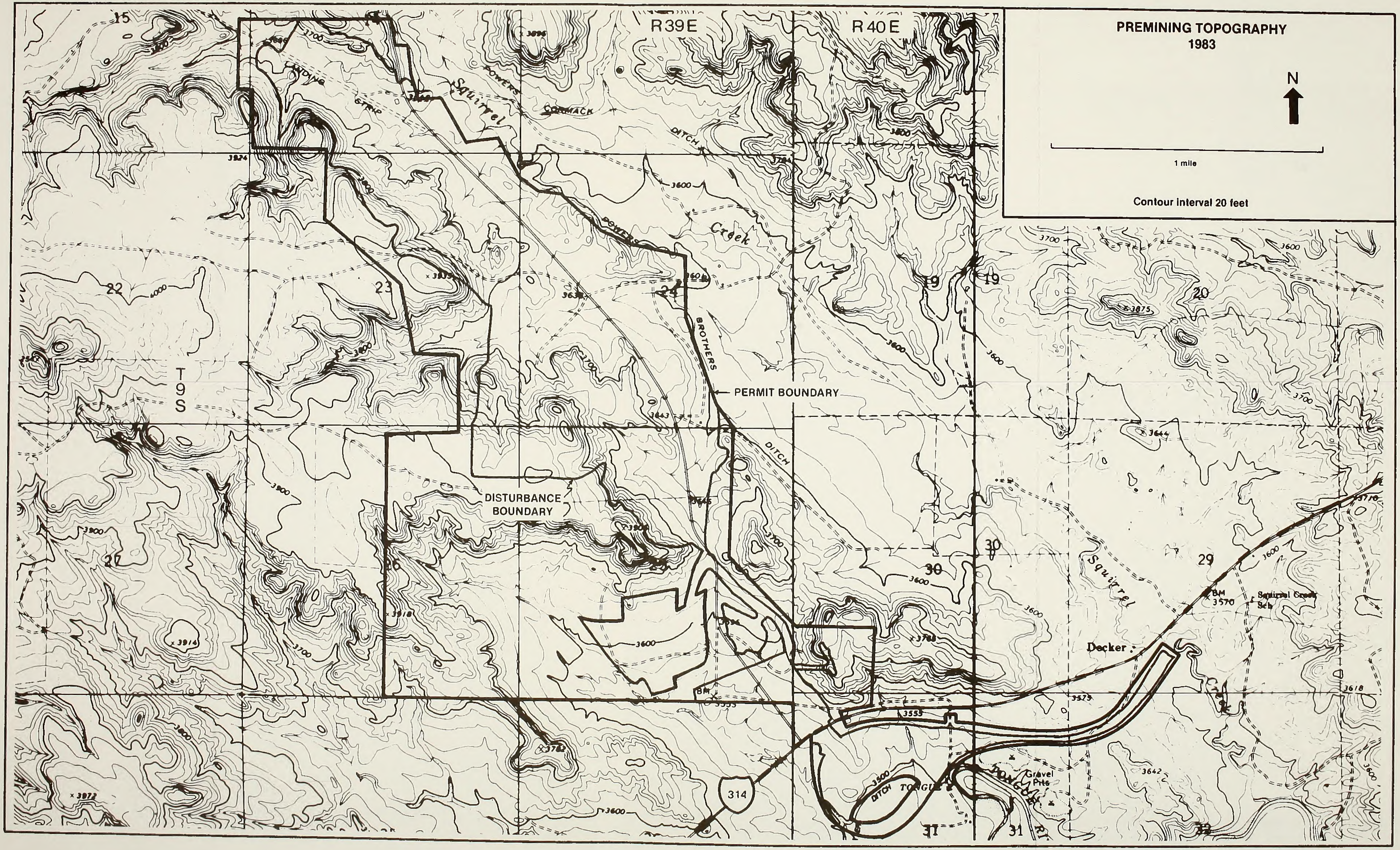


FIGURE 1-6 Most of the lands Consol plans to disturb are flat or gently rolling, interrupted by small hills and rock outcrops. The western margin of the disturbance area, however, rises steeply to the uplands west of the 12-year permit area.

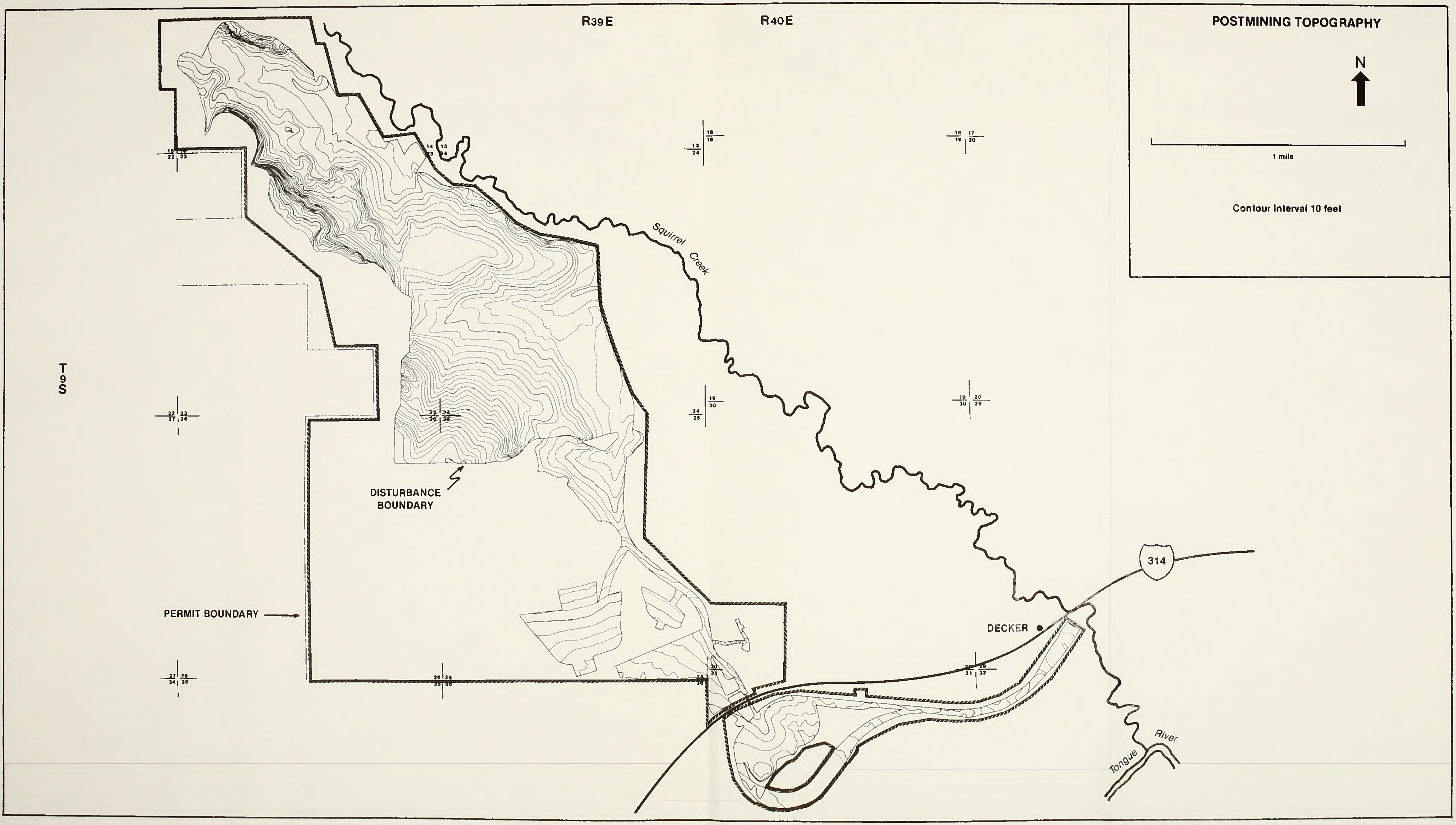
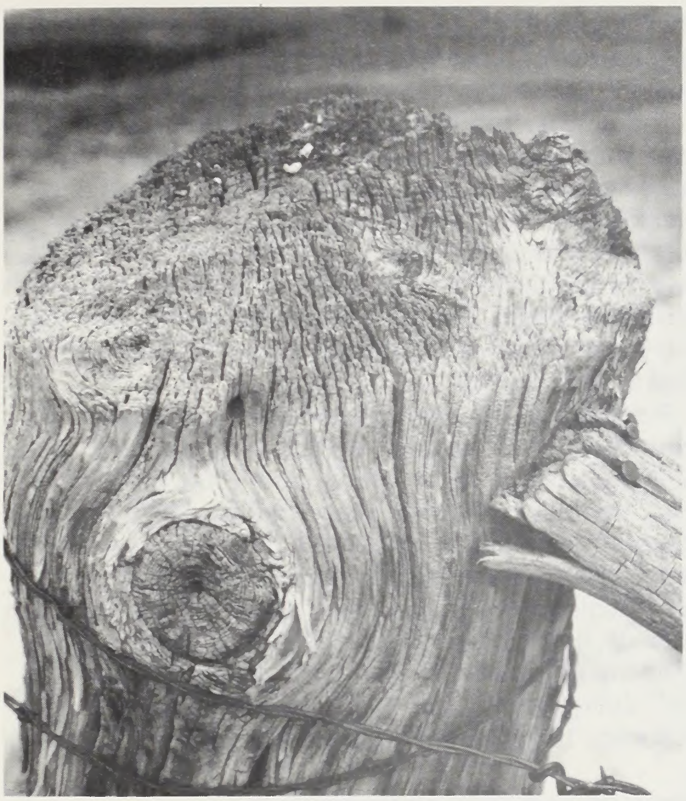


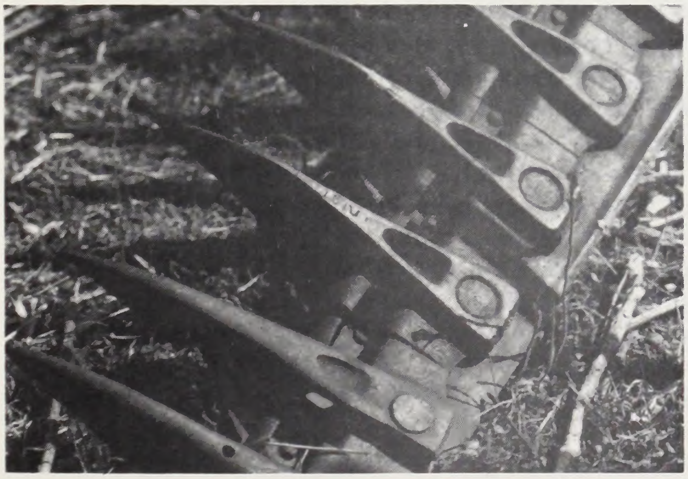
FIGURE 1-7 Postmining landforms and drainages would closely resemble the topography present before mining. Abrupt hills and outcrops would be removed. Compare with figure 1-6.



CHAPTER

2

THE AFFECTED ENVIRONMENT



An analysis of Consolidation Coal Company's proposal requires that the EIS cover 18 topics, representing the "environment" of the CX Ranch today. This environment encompasses the resources, enterprises, services, facilities, and people that could be affected by the company's new mine.

The selection of EIS topics was guided by public and government agency concerns and Federal and State regulations. Analysts from the Department of State Lands and the Department of the Interior compiled the issues they felt were important. The public added its concerns through letters and a public meeting held in 1982. (See introduction.)

The topics analyzed generally include information on only those parts of the environment that could be affected, directly or indirectly, by the mine. For the sake of brevity, the parts of the environment that are not expected to be affected have not been discussed.

Note that the chapter not only describes the condition of the social, economic and natural environment today, but also the condition this environment would be in if the CX Ranch Mine never opened. This means the chapter does contain projections of the future—but a future without the mine. Chapter 3 goes on to project the mine's effect, including additional projections of a future with the mine.

GEOLOGY

TOPOGRAPHY AND GEOMORPHOLOGY

The CX Ranch Mine 12-year permit area lies at the lower (southeastern) end of the Squirrel Creek drainage basin (fig. 2-1). The topography and land forms of the basin are typical of southeastern Montana. In places, local vertical relief, or elevation change, is over 400 feet. The highest point within the permit area is a hill located in the central portion, rising to over 3,940 feet. The lowest point within the area is a terrace of the Tongue River (elevation 3,500 feet), where the proposed rail loop would be located.

The average width of the Squirrel Creek valley is about 1,300 feet. The valley bottom gradually widens downstream, reaching a width of 3,000 to 4,000 feet near the Tongue River.

The 12-year permit area is bounded on the west by flat upland plateaus. These plateaus comprise erosion-resistant clinker (baked strata above burned-out coal seams) and sedimentary rocks of the Wasatch Formation. The plateaus reach about 3,900 feet in elevation. The landscape of the permit area generally drops in elevation from the plateaus northeastward toward Squirrel Creek (3,600 feet).

In the 12-year permit area, Squirrel Creek is fed by five ephemeral tributaries (drainages that flow only in response to heavy precipitation or rapid snowmelt). The southern third of the permit area extends into a small southeast-draining basin (in sections 25 and 26; south of the 12-year mine pit). Runoff from this basin flows directly into the Tongue River.

The pattern of sediment erosion, transport, and deposition within the Squirrel Creek drainage is typical for lands found in a semiarid climate. Most sediment eroded from uplands settles on lower slopes, where runoff water slows down or infiltrates into the ground. As a result, little of the eroded sediment actually leaves the Squirrel Creek basin. Hillslope erosion initiated by livestock contributes noticeably to natural erosion within the basin.

Erosion rates on undisturbed areas within the Squirrel Creek basin probably range from near 0 to over 20 tons per acre per year, averaging about 1 ton per acre per year (derived from the Universal Soil Loss Equation, King et al., 1977). Variability in the estimated erosion rates stems from many factors, the most important of which are geology, climate, slope, and vegetation. Field data and predictive equations are unavailable for this area; however, Consol plans to initiate studies to better measure the erosion rates of undisturbed and reclaimed lands.

Erosion rates are usually highest during rapid snowmelt and intense or prolonged rainstorms. Sheetwash (thin sheets of runoff) and rain splash are probably the major erosion processes over most of the minesite. Gullying dominates where runoff water concentrates.

The smaller tributaries to Squirrel Creek probably have relatively high sediment yield rates, carrying more sediment per square mile per year than Squirrel Creek itself. These tributaries transport about 30 to 40 percent of the eroded sediment to Squirrel Creek. Even so, only about 10 percent of the total sediment actually leaves the basin. The rest settles along the tributary and main channels of Squirrel Creek (Consolidation Coal Company, 1984, vol. 8, p. 103).

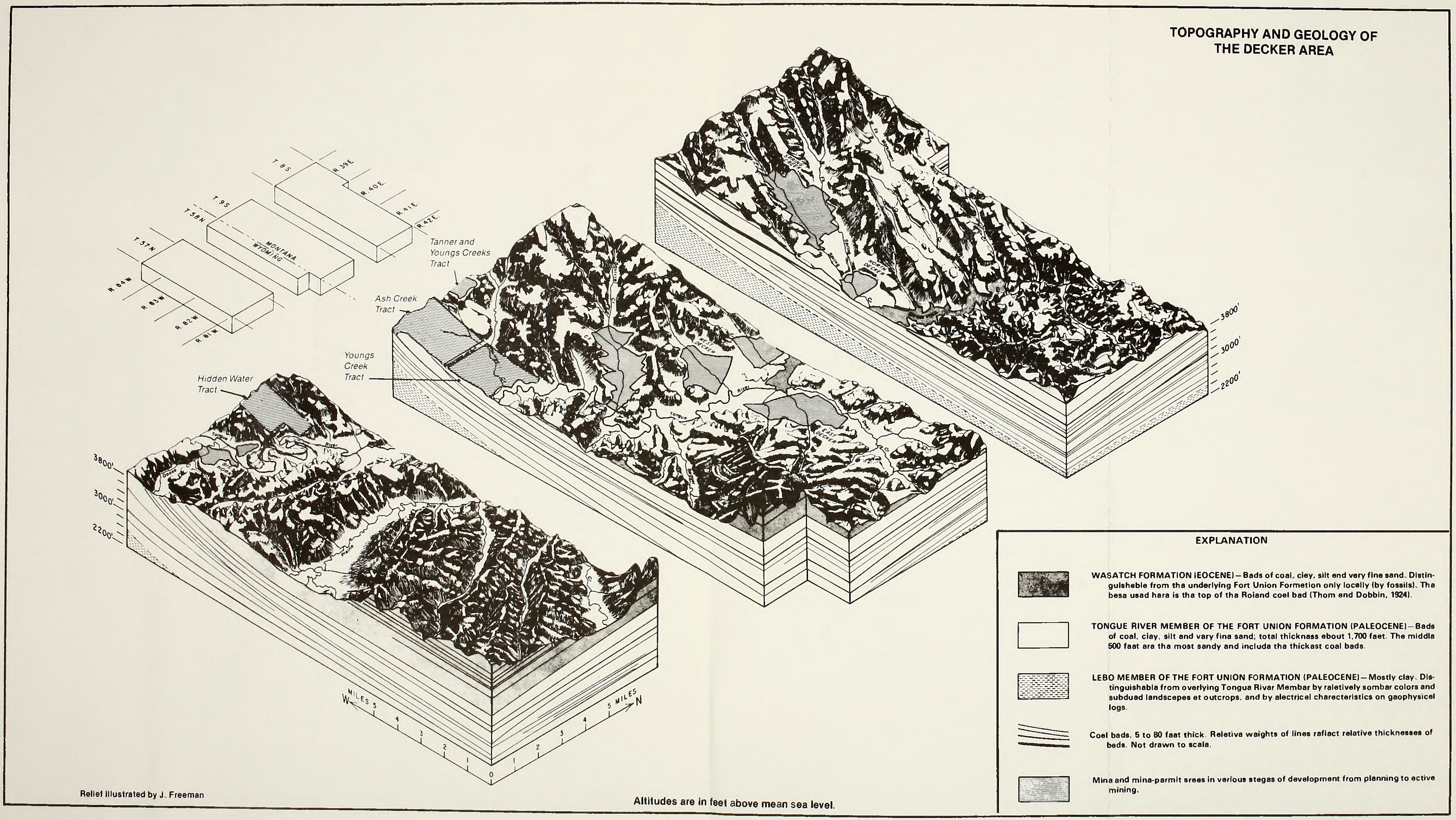
Profiles of channel elevations (headwaters to mouth) of the ephemeral creeks in and around the minesite do not show the smooth, concave profile found in many less arid areas. Instead, channels are steep in some places and flat in others. In the steep reaches, active channel downcutting and some gully development generally takes place. In the gentle reaches, deposition occurs. The alternating sequence of downcutting and deposition is common in ephemeral drainages in the semiarid west (Patton and Schumm, 1975; Schumm and Hadley, 1957).

STRUCTURE AND STRATIGRAPHY

Only two bedrock units are exposed within the Squirrel Creek basin: the Wasatch Formation and the underlying Tongue River Member, the youngest member of the Fort Union Formation (fig. 2-2). Overlying the bedrock units are recent unconsolidated (Quaternary) deposits of various composition and origin. Structurally, the bedrock dips slightly (about 1 to 3 degrees) to the southeast. Superimposed on this nearly flat-lying structure are slight flexures (folds) and a number of faults. Early geologic studies by Baker (1929) and Rogers and Wallace (1923) have been supplemented by more detailed and recent work in the region by Bryson and Bass (1973), Law and Grazis (1972), and Cole and Sholes (1980).

The Squirrel Creek valley is located on the western flank of the Powder River Basin, a major structure of considerable economic significance to the coal industry of Montana and Wyoming. The Big Horn Mountains, a major uplifted area, lie southwest of the minesite. The Decker area itself lies on the northern flank of the Ash Creek anticline (upward bowed flexure).

The drainage pattern of the Decker area appears to be controlled largely by the orientation of bedrock fractures and faults. Two distinct directions of lineation (geologic alignment) occur, one oriented north-northeast–south-southwest and another west-northwest–east-northeast. The two directions of lineation are roughly 90 degrees apart. The fracture and faulting pattern probably results from the release of tension created by the uplift of the Bighorn Mountains and downwarping of the Powder River Basin.



EXPLANATION

▩	**WASATCH FORMATION (EOCENE)**—Beds of coal, clay, silt and very fine sand. Distinguishable from the underlying Fort Union Formation only locally (by fossils). The base used here is the top of the Roland coal bed (Thom and Dobbin, 1924).
☐	**TONGUE RIVER MEMBER OF THE FORT UNION FORMATION (PALEOCENE)**—Beds of coal, clay, silt and very fine sand; total thickness about 1,700 feet. The middle 500 feet are the most sandy and include the thickest coal beds.
▤	**LEBO MEMBER OF THE FORT UNION FORMATION (PALEOCENE)**—Mostly clay. Distinguishable from overlying Tongue River Member by relatively somber colors and subdued landscapes at outcrops, and by electrical characteristics on geophysical logs.
☰	Coal beds, 5 to 80 feet thick. Relative weights of lines reflect relative thicknesses of beds. Not drawn to scale.
▨	Mine and mine-permit areas in various stages of development from planning to active mining.

FIGURE 2-1 Streams and drainages around Decker all flow into the Tongue River. Elevations vary as much as 500 feet, alternating between shallow valleys and broad, flat uplands. The strata underlying the region change only gradually from one location to another. (Drawing modified from Van Voast and Thompson, 1982.)

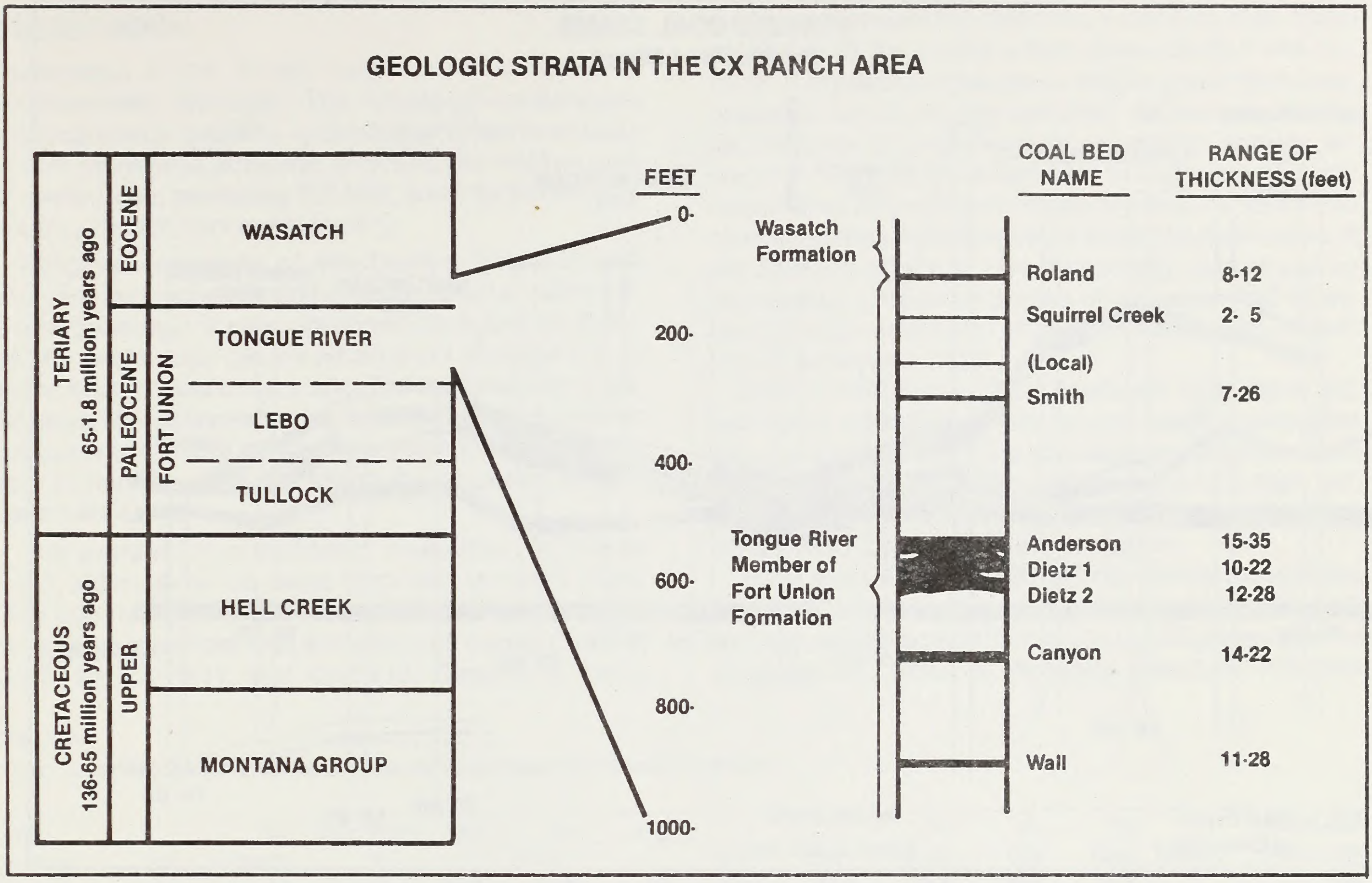


FIGURE 2-2 The strata of most significance to mining in the region lie within the Tongue River Member of the Fort Union Formation, which contains the coal seams Consol plans to mine.

Near the CX Ranch minesite, four major faults have been identified. (See Hydrology, fig. 2-5.) All four faults trend east-northeast and drop down on the southeastern side. Fault offsets range from 150 to 250 feet, and fault lengths vary from 4 to 10 miles. None pass directly through the proposed 12-year mine pit. No evidence of recent movement has been documented, nor is any movement likely, judging from the lack of earthquakes in the region.

The Tongue River Member of the Fort Union Formation comprises stream-laid deposits of sandstone, siltstone, shale, and coal. The Fort Union deposits, part of a thick wedge of sediments eroded from the emerging Rocky Mountains to the south and west, were deposited in the gradually subsiding Powder River Basin. The thick seams of subbituminous coal within the Tongue River member are believed to have developed from dense tropical forest during periods when the landscape was intermittently stable (Widmayer, 1973, p. 46).

In the Decker area, at least nine coal beds lie within the upper part of the Tongue River Member (fig. 2-2). Different authors and mines label the seams differently because of individual preferences (table 2-1). Many coal beds maintain constant thickness and good lateral continuity. Other seams split and rejoin or pinch out completely. Near Squirrel Creek, the Anderson, Dietz 1 and Dietz 2 seams join to form one 70- to 85-foot-thick seam, here called the Anderson/Dietz. The three seams split in all directions away from the minesite (fig. 2-3).

TABLE 2-1

Decker Area Coal Seams

CX Ranch Mine Designation	Wyoming Designation	Big Horn Mine Designation[1]	Decker Mine Designation	Youngs/Tanner Creek Designation
Roland	Roland	Roland	Roland	Roland
Smith	Smith	Smith	Smith	Smith
Anderson	Dietz 1	Dietz 1	D1 Upper	G
Dietz 1[2]	Dietz 2	Armstrong	D1 Lower	M
Dietz 2[2]	Dietz 3	Upper Monarch	D2	M
Canyon	Monarch	Lower Monarch	D3	O
Wall	Carney	Carney	D4	Wall

[1] The Bighorn Mine now uses the Wyoming terminology.

[2] The Dietz 1 and Dietz 2 seams, when combined, are known as the Dietz seam.

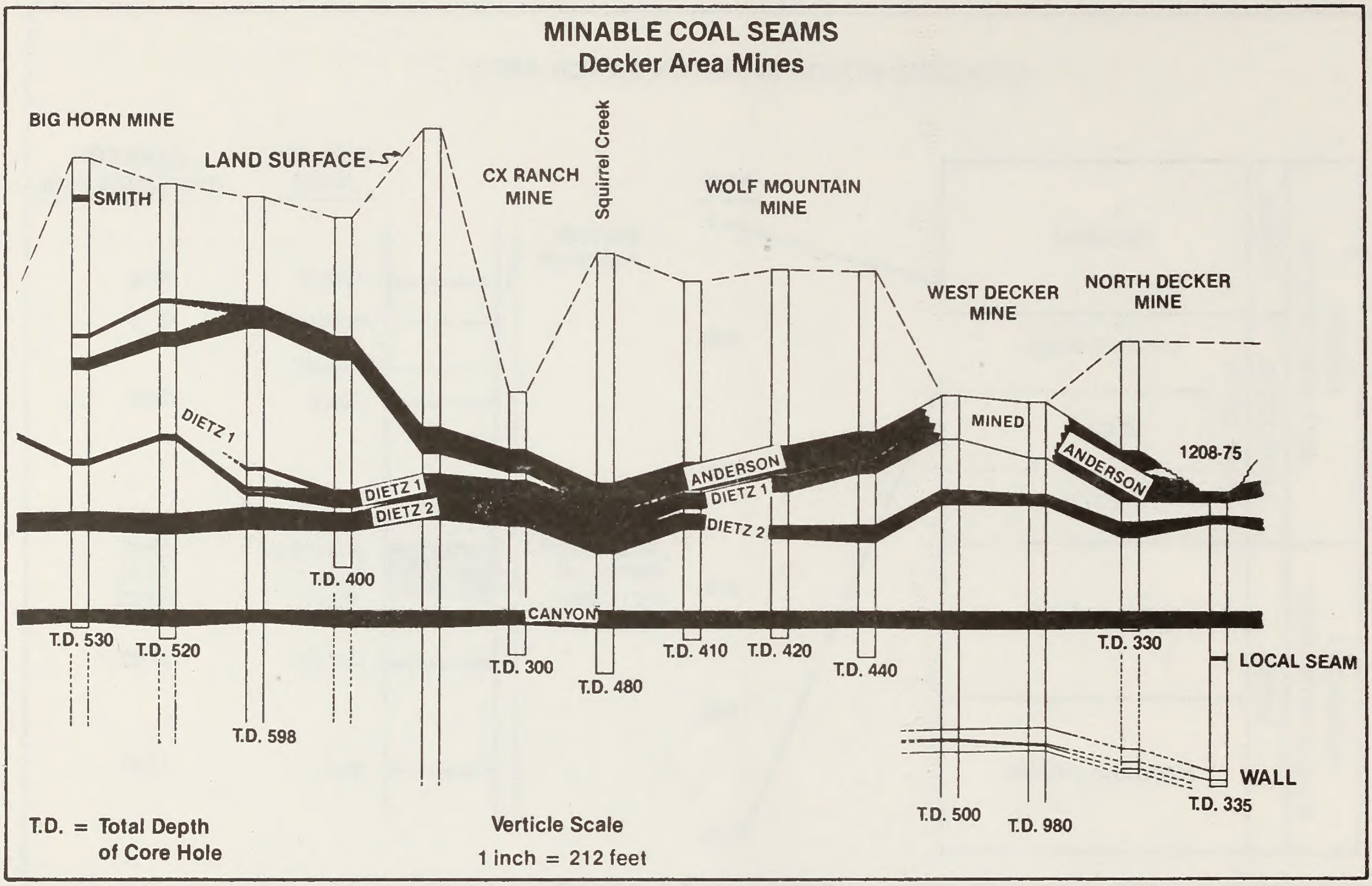


FIGURE 2-3 Core hole data show that the location and depth of coal seams vary throughout the Decker area. Near Squirrel Creek, where Consol plans to mine, three seams combine to form the Anderson/Dietz, the primary seam the company would recover. Note that the figure is approximate and not to scale. (Source of Data: Kiewit Mining and Engineering Company)

The Smith, Squirrel Creek, and Roland coal seams are the only coal beds of the Tongue River Member exposed on the surface in the Squirrel Creek drainage. Most of the coal in these three seams has either burned (yielding material called clinker, scoria, or porcellanite) or eroded. These seams are thin and not considered of economic importance.

The combined Anderson/Dietz coal seam and the underlying Canyon seam are the targets of the CX Ranch Mine. The seams generally lie closest to the surface under the valley bottoms (Squirrel Creek, Spring Creek, and Tongue River valleys). Because the surface elevation increases southwest of Squirrel Creek, the thickness of overburden (bedrock and unconsolidated deposits covering the coal seam) within the proposed 12-year pit also increases to the southwest. The thinnest overburden (200 to 240 feet) is located beside Squirrel Creek, the deepest overburden (over 500 feet) is located along the southwestern edge of the mine.

The overburden within the CX Ranch minesite is composed primarily of alternating and intergrading sandstone, siltstone, and shale strata. The interburden—the strata between the Anderson/Dietz and Canyon coal seams—is similar. The interburden ranges in thickness from 60 to 90 feet and averages about 75 feet. The Canyon coal seam maintains a thickness of 20 to 22 feet and in the Decker area lies at a relatively constant elevation, much more so than the coal seams above and below it (figs. 2-2 and 2-3). The bottom of the Canyon coal seam lies 260 to 600 feet below the surface. Sandstone and shale strata and the Wall coal seam lie below the Canyon seam.

PALEONTOLOGY

No important paleontological (fossil) resources have been identified in the Decker region, although significant fossil plant remains are known to exist elsewhere in the Tongue River Member of the Fort Union Formation (Brown, 1962).

MINERALS OTHER THAN COAL

There are no known oil or gas reserves within the 12-year permit area. Five wildcat wells drilled to test Cretaceous formations near Decker were dry. Two of these wells are located within the West Decker Mine permit area.

Clinker is abundant along the southwestern margins of the minesite. Clinker is used on road surfaces and as riprap. Alluvial sands and gravels are present, but are not extensively used.

OVERBURDEN

Overburden in the 12-year permit area is typical of southeastern Montana. The lithology—observable physical characteristics—consists of intermixed beds of soft sandstone, siltstone, and clay. The thicknesses of overburden, averaging 250 feet, and interburden, averaging 75 feet, vary considerably.

Weighted averages of overburden physical and chemical properties by drill core are given in table 2-2. Corresponding drill sites are shown on figure 2-4. Overall, the overburden has an alkaline pH of about 8.2, is low in salinity, and often sodic. The material that is sodic would be unfavorable for reclamation; however, an adequate amount of salvageable material with acceptable sodium levels exists within the proposed 12-year permit area.

The average unconsolidated overburden texture is loam, although strata range from clay to sandy loam. Clay mineralogy analyses were performed on four different samples from four different drill cores: CX-79-2, CX-79-10, CX-79-11, and CX-79-13. Results of these analyses showed that smectite, a swelling clay, dominated two of the samples from cores CX-79-2 and CX-79-13. It is possible that these results could have been predicted based on the samples' saturation percent (an indicator of water-holding capability), sodium adsorption ratio (SAR—a measure of sodicity), and corresponding clay content values. By use of these three characteristics as indicators of smectite dominance in the absence of actual clay mineralogy data, it can be speculated with some degree of accuracy that smectite is the dominant clay mineral in much of the 12-year permit area overburden.

Overburden sulfate (SO_4) levels are high (table 2-2) and could potentially affect ground water quality. (See chapter 3, Hydrology.) The acid-base potentials and pH values (table 2-2) are also high, indicating a high buffering capacity in the overburden, which would neutralize any acid formed by pyrite oxidation.

Trace element concentrations in the overburden are low. The only exception to this is nickel, for which all average values exceed 1.0 ppm (table 2-2). No problems are expected, however. Available literature indicates

TABLE 2-2

Weighted Averages of Overburden Physiochemical Characteristics by Drill Core

Core Number	pH	EC[1] (mmhos/cm)	Saturation %	Na	Ca	Mg	SAR[3]	ESP[4]	% Sand	% Silt	% Clay	Texture[5]	Acid-Base Potential[6]
				meq/l[2]									
CX-79-2	8.8	1.5	141	34.9	21.9	3.3	15.7	17.3	39.8	39.6	20.6	L	+90
CX-79-3	7.2	2.0	142	10.0	5.0	5.2	12.4	13.9	41.3	38.8	19.9	L	+106
CX-79-4	8.8	2.0	206	13.7	3.5	2.2	16.3	18.3	36.1	39.4	24.5	L	+119
CX-79-6	8.0	2.4	86	15.7	2.4	2.4	18.2	19.5	19.9	53.3	26.8	SiL	+118
CX-79-7	8.6	1.8	139	16.5	5.8	4.9	14.9	16.5	45.9	34.3	19.8	L	+111
CX-79-10	8.0	2.4	117	11.8	2.6	1.7	14.7	16.2	27.8	47.8	24.4	L	+114
CX-79-11	8.3	1.9	121	18.2	3.4	2.1	24.5	24.6	37.9	42.8	19.3	L	+106
CX-79-13	8.3	2.3	122	22.6	11.8	4.5	25.2	23.8	28.3	45.8	25.9	L	+105
CX-79-15	8.5	2.2	161	11.6	3.5	4.2	11.3	13.4	22.8	21.6	55.6	C	+67
CX-79-20	8.0	2.6	60	17.0	4.6	3.7	14.3	15.8	50.1	31.9	18.0	L	+128
CX-79-23	7.7	4.1	79	20.9	6.4	9.4	13.0	15.1	35.2	40.0	24.8	L	+99

Core	SO_4	B	Cu	Fe	Pb	Mn	Zn	Ni	Cd	Se	Hg	Mo	NO_3-N	NH_4-N
						parts per million[7]								
CX-79-2	732	<0.2	3.7	56	2.1	6.4	3.6	3.5	0.08	0.06	0.03	0.2	5.1	29.0
CX-79-3	933	0.3	3.0	67	2.3	21.2	14.4	1.4	0.09	0.05	0.04	0.1	3.2	19.6
CX-79-4	723	0.3	1.7	45	2.4	4.5	5.5	1.5	0.14	0.04	0.05	0.2	1.3	80.2
CX-79-6	481	<0.2	4.2	76	2.6	8.3	8.3	4.0	0.13	0.10	0.06	0.2	1.0	16.1
CX-79-7	1,289	<0.2	1.2	35	2.3	6.8	12.7	2.0	0.04	0.07	0.03	0.2	2.4	17.3
CX-79-10	729	0.4	4.2	95	2.8	7.1	10.7	3.0	0.11	0.04	0.06	0.2	1.9	23.9
CX-79-11	633	0.2	4.4	75	4.1	6.9	4.7	2.9	0.14	0.05	0.05	0.2	1.0	28.3
CX-79-13	1,061	0.3	3.8	86	4.3	7.6	6.2	4.2	0.12	0.04	0.04	0.2	1.0	23.3
CX-79-15	3,125	<0.2	1.3	37	1.1	2.9	3.2	2.2	0.04	0.03	0.03	0.2	2.7	20.5
CX-79-20	782	<0.2	2.9	63	2.5	5.6	4.3	3.9	0.16	0.04	0.03	0.2	1.0	12.6
CX-79-23	975	<0.2	1.6	39	1.1	3.6	3.5	1.1	0.03	0.05	0.05	0.2	7.3	16.5

[1] Electrical conductivity (a measure of salinity) in millimhos per centimeter.

[2] Milliequivalents per liter; Na = sodium; Ca = calcium; Mg = magnesium.

[3] Sodium adsorption ratio (a measure of sodicity).

[4] Exchangeable sodium percentage (a measure of sodicity).

[5] L = loam; SiL = silt loam; C = clay.

[6] Units = ± tons of calcium carbonate equivalent per 1,000 tons of overburden material.

[7] SO_4 = sulfate; B = boron; Cu = copper; Fe = iron; Pb = lead; Mn = manganese; Zn = zinc; Ni = nickel; Cd = cadmium; Se = selenium; Hg = mercury; Mo = molybdenum; NO_3-N = nitrate nitrogen; NH_4-N = ammonium nitrogen.

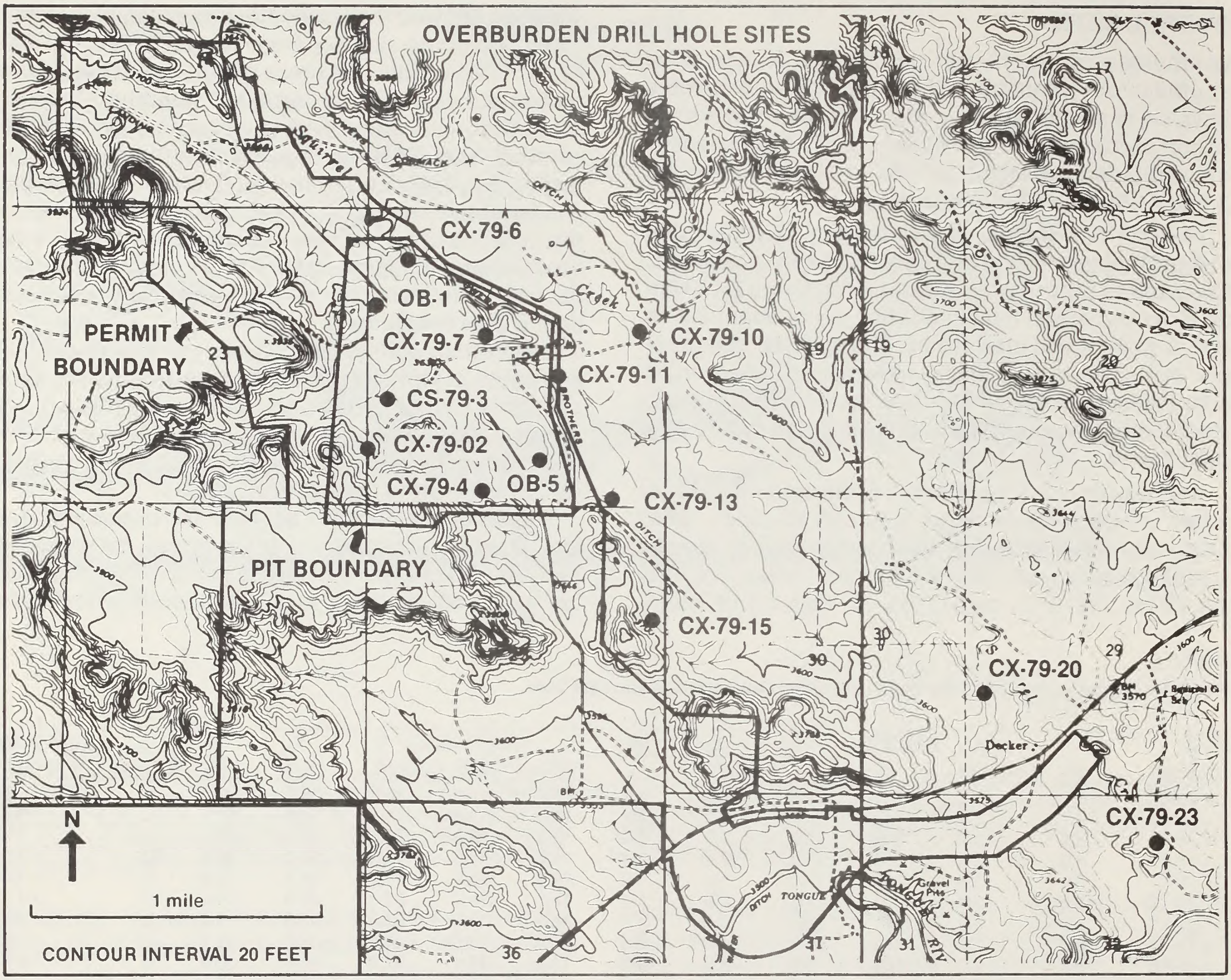


FIGURE 2-4 Consol has drilled a number of core holes to evaluate the physical and chemical properties of the overburden rock strata lying over the coal. The resulting analyses can be used to determine the suitability of the overburden for replacement in the postmining rootzone or aquifers.

that nickel uptake is restricted by environmental factors (such as alkaline soil conditions); therefore, the Department of State Lands' draft 1983 Soil and Overburden Guidelines no longer include a suspect level for the element. (See chapter 3, Geology, Overburden.)

HYDROLOGY

GROUND WATER

The major aquifers (water-bearing strata) in the 12-year permit area are Squirrel Creek alluvium (stream-laid deposits), the Anderson/Dietz coal, the Canyon coal, and the Wall coal. Other aquifers include the overburden above the Anderson coal and the alluvium along the Tongue River and Youngs Creek.

The alluvium along Squirrel Creek is about 0.25 to 0.5 mile wide and up to about 70 feet thick. It consists of up to 45 feet of coarse sand and gravel overlain by 10 to 30 feet of clay, silt, and fine sand. In the upper reaches of the creek, water appears to flow freely between the stream and the deeper, coarse gravel layer. Farther downstream, however, the finer alluvial material covering the coarse gravel reduces water exchange. The restriction of upward movement raises ground water pressures in the deep alluvium of lower Squirrel Creek, creating artesian ground water conditions.

The ability of the Squirrel Creek alluvium to transmit water varies from one place to another (table 2-3). This variability results from changes in permeability of the transmitting alluvium. (For example, silt- and clay-dominated alluvium generally have low permeability and therefore transmit little water.) Based on hydrologic studies, about 80 percent of the ground water flowing through the Squirrel Creek alluvium appears to move through the deeper coarse gravel.

The alluvial ground water generally is of the sodium-magnesium-sulfate type (a classification indicating the major ions present) and is very hard. The quality usually worsens downstream, mainly from the return flow of irrigation water. Near the upstream end of the 12-year permit area, total dissolved solids (TDS) concentrations range from 1,300 to 1,600 milligrams per liter (mg/l), increasing to generally more than 6,000 mg/l near the downstream permit boundary during low flow. (Note that large irrigated fields lie between these two sampling points.) Because of the high TDS levels, alluvial water below the irrigated fields is not used for domestic purposes or irrigation. It is marginally suited for livestock and wildlife.

The overburden above the Anderson coal is up to several hundred feet in thickness. The sandstone strata within the overburden are generally thin, discontinuous, hold little water (table 2-3), and generally have poor quality water (TDS concentrations: 1,700 to 6,300 mg/l). As a result, the overburden is usually not tapped for water. The few stock wells that do draw from the overburden yield only a few gallons per minute.

The Anderson, Dietz 1, and Dietz 2 coal seams are the most often used aquifers in the Decker area. At the minesite, the three seams join into the single Anderson/Dietz coal seam, which has an average thickness of 83 feet. Ground water occurrence in the Anderson/Dietz aquifer varies with the amount of fracturing in the coal. Hydraulic conductivity values (the ability to transmit water per unit area) vary by more than tenfold, again depending on the degree of coal fracturing (table 2-3).

Water flow in the Anderson/Dietz coal of the minesite is affected by several northeast-trending faults. The faults break the aquifer into separate blocks, obstructing most cross-fault ground water movement and offsetting the potentiometric (ground water elevation) contours (fig. 2-5). Most of the CX Ranch minesite lies within a single fault block. Ground water within the block enters the Anderson and Dietz aquifers in the vicinity of Ash, Youngs, and Tanner creeks (fig. IN-2). After flowing northeast through the proposed 12-year CX Ranch and Wolf Mountain minesites, the water eventually discharges to the West Decker Mine pit. Before excavation of the West Decker pit, ground water in this fault block discharged directly to the Tongue River Reservoir.

Potentiometric levels (the height of water in a well) in the Anderson/Dietz coal have fallen north and east of the CX Ranch minesite as a result of mining at the West Decker Mine. By the end of 1981, after 9 years of mining, water levels in observation wells had declined about 42 feet within 0.6 mile of the pit and about 6 feet within 2 miles of the pit. Water flowing into the West Decker pit is discharged to the Tongue River Reservoir.

The ground water in the coal seams generally is soft and of the sodium-bicarbonate type. TDS concentrations range from 700 to 2,800 mg/l. The water is used for livestock watering, but is of low suitability for irrigation, owing to high sodium concentrations and a generally moderate to high salinity hazard. For lack of better sources, the water is also often used for domestic purposes, although TDS concentrations exceed the recommended limit of 500 mg/l for domestic water supplies.

The Canyon coal seam, 19 to 20 feet thick, lies 65 to 100 feet below the Anderson/Dietz seam. The Canyon coal's water-bearing properties resemble those of the overlying Anderson/Dietz aquifer. Ground water in the Canyon moves in the same general northeasterly direction as the overlying Anderson/Dietz and appears to be influenced by the northeast-trending faults as well. The Canyon contains soft, sodium-bicarbonate type water. Measured TDS concentrations range from 1,200 to 1,800 mg/l. The water frequently contains methane, hydrogen sulfide, and carbon dioxide gases. Only one well in the area obtains water from the Canyon seam.

The Wall coal seam, 20 to 35 feet thick, lies 126 to 168 feet below the Canyon coal. Aquifer properties, such as water quality and potential for producing water, though not well known, are believed to be similar to those of the Canyon coal.

Little information is available on the Tongue River alluvium near the CX Ranch. The aquifer is known to supply only three wells in the Decker area. The wells range from 17 to 35 feet in depth. Most wells tap strata below the alluvium to avoid bacterial contamination from sewage system discharges and agricultural activities upstream. With treatment, Tongue River alluvial water could be used for domestic water supplies.

TABLE 2-3

Characteristics of Aquifers at the CX Ranch Mine

		Transmissivity			Storage Coefficient		
Aquifer	Thickness (feet)	Number of Determinations	Range (gal/day/ft)	Median	Number of Determinations	Range	Median
Squirrel Creek alluvium	0-72	63	4,435-85,272	31,935	31	0.0002-0.34	0.029
Anderson overburden	30-200	4	0.1-344	98	0	unknown	unknown
Anderson/Dietz Coal	70-83	26	127.2-6,665	1,917	4	0.00000072-0.000595	0.000218
Canyon Coal	19-20	19	162-4,312	1,880	2	0.0000012-0.000055	0.000028

Source: Consolidation Coal Company, 1984; Kiewit Mining and Engineering Co, 1981.

SURFACE WATER

The CX Ranch 12-year permit area is drained mainly by tributaries to Squirrel Creek, a perennial stream that flows into the Tongue River less than 1 mile east of Consol's proposed rail loop. All tributaries to the creek are ephemeral, flowing only during snowmelt or heavy rains. The CX Ranch 12-year permit area takes up about 6 percent of the creek's 50.6-square-mile drainage area. Squirrel Creek originates about 12 air miles to the northwest of the CX Ranch Mine in the Wolf Mountains on the Crow Reservation. It flows southeast, past the CX Ranch minesite, entering the Tongue River about one-half mile north of the Wyoming-Montana border.

Most years, flow in Squirrel Creek is less than 3 cubic feet per second (cfs) two-thirds of the time and less than 1.5 cfs half the time. The average annual runoff at the U.S. Geological Survey (USGS) gaging station, located upstream of the minesite, is 3.8 cfs, or 1,700 gallons per minute. Runoff rates and stream flows are usually highest in late winter through early spring, as a result of snowmelt and rainfall, and lowest in late summer through winter (table 2-4).

The most important factor controlling flow in Squirrel Creek is the low amount of precipitation falling within the drainage. Other factors include water losses to both evaporation and the underlying alluvium. Irrigation diversions above the minesite usually remove most available water during late summer, and at times eliminate flow entirely.

Base flow in Squirrel Creek above the irrigation diversions, although small, is nearly constant. Base flow is maintained by the gradual release of water stored in the soil, alluvium, and bedrock along Squirrel Creek.

Peak flood flows in Squirrel Creek can be large (table 2-5). For example, the predicted 100-year flood at one site is as much as 212 times larger than the mean annual flow rate (table 2-5). Unseasonably warm weather combined with heavy snowpack often causes the most severe winter runoff. Heavy rain or rapid snowmelt can significantly increase runoff at any time of the year.

Water in Squirrel Creek is of the magnesium-bicarbonate type, is very hard, and has a medium to high salinity hazard. TDS concentrations above the irrigation diversions range from about 350 mg/l during high flows to about 2,700 mg/l during low flows. Water quality worsens downstream, as dissolved solids are concentrated by evaporation and as irrigation water returns to the creek. TDS concentrations have exceeded 6,000 mg/l during low flows near the mouth of the creek.

TABLE 2-5

Flood Size and Frequency Along Squirrel Creek

	Average Number of Years Between Runoff Events					
Gaging Station	2	5	10	25	50	100
USGS site (33.5 mi²) in cfs[1]	59	164	270	443	609	806
KME site (49.9 mi²) in cfs	115	318	526	869	1,201	1,596

Source of prediction methodology: Johnson and Omang, 1976.

Note: The KME site is maintained by Kiewit Mining and Engineering Company near the mouth of the creek.

[1] Based on continuous recorder dates gathered from 1976 to 1982 (Bob Omang, U.S. Geological Survey, written com., December 1983).

Consol placed a continuous-flow-gage recorder on one of the ephemeral creeks draining the minesite. Since May 1980, three flows were recorded. The smallest flow recorded was 13 gpm; the largest, 2,950 gpm, occurred during rapid snowmelt. One water quality sample was collected on this drainage during the smallest recorded runoff. The water was soft, low in total dissolved solids, and of the calcium-bicarbonate type.

Suspended sediment loads in Squirrel Creek during 1982 ranged from 46 mg/l on February 22 to 240 mg/l on March 16. Suspended sediment in runoff from the only gaged ephemeral creek at the minesite was high: 6,260 mg/l on June 21, 1982.

Nitrate and ammonia concentrations in Squirrel Creek are relatively high. Ammonia concentrations rise high enough 15 to 20 percent of the time (during spring and summer) to potentially harm fish. (See Fisheries.)

The nitrate and ammonia concentrations vary throughout the year. Ammonia concentrations are highest from March to August; they generally drop to low levels during the fall and winter (table 2-6). Although high and low nitrate concentrations appear to be more evenly distributed throughout the year, the higher values, as with ammonia, occur during spring and summer. These periods are more critical to aquatic life in Squirrel Creek because of higher water temperatures. (See Fisheries and Aquatic Ecology.)

TABLE 2-4

Monthly Average Flow in Squirrel Creek Above Mine Area (33.5 square miles)

Month	Jan	Feb	March	April	May	June	July	Aug	Sept	Oct	Nov	Dec
Flow (cfs)	0.9	1.5	3.7	12.0	15.0	6.0	1.7	0.7	0.5	0.9	1.0	1.1

Note: Averages computed based on continuous recorder data from 1976 to 1982, U.S. Geological Survey gaging station (Bob Omang, written com., December 1983).

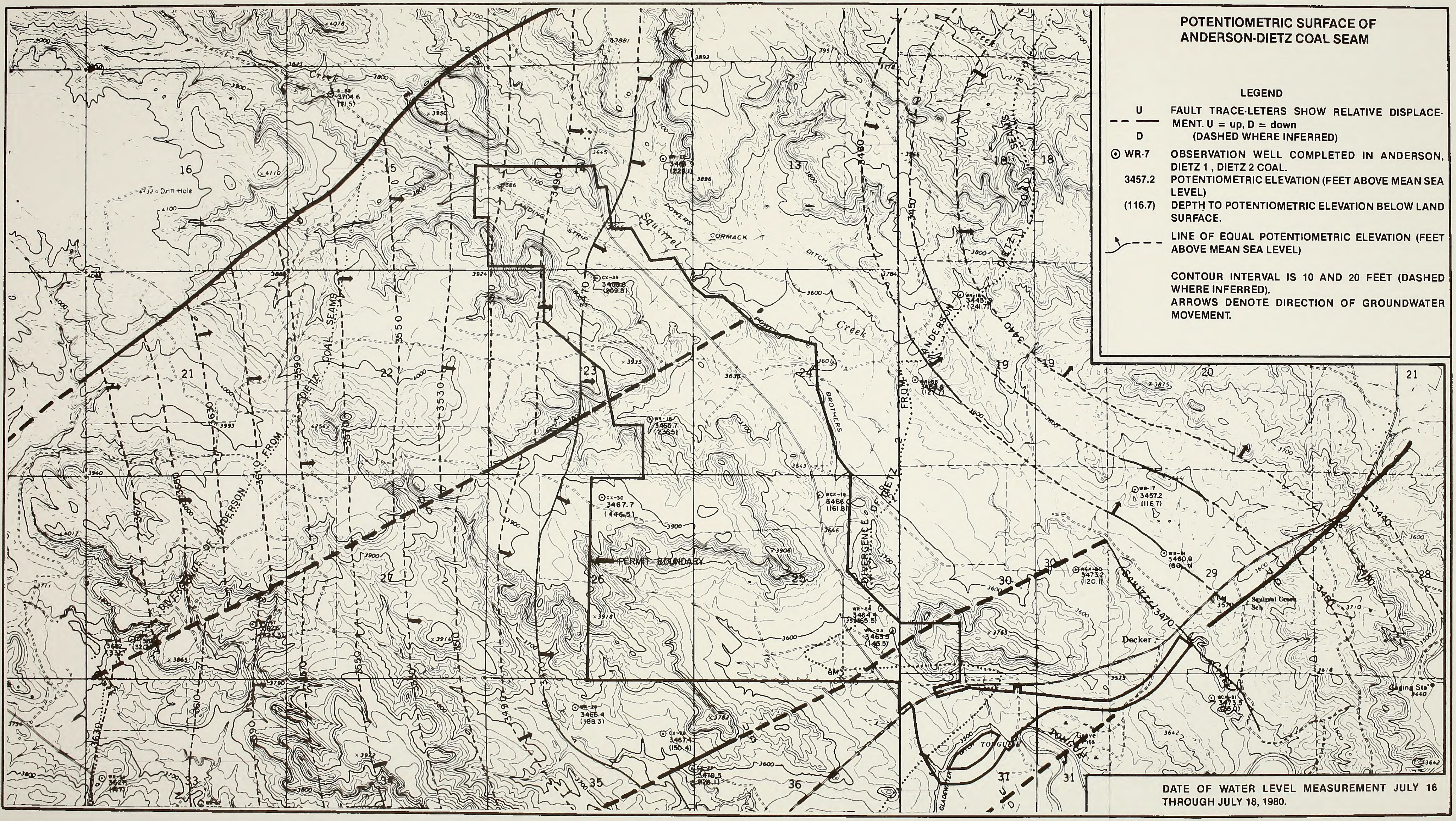

POTENTIOMETRIC SURFACE OF ANDERSON-DIETZ COAL SEAM
LEGEND
U
D
FAULT TRACE-LETERS SHOW RELATIVE DISPLACEMENT. U = up, D = down (DASHED WHERE INFERRED)
WR-7 OBSERVATION WELL COMPLETED IN ANDERSON, DIETZ 1, DIETZ 2 COAL.
3457.2 POTENTIOMETRIC ELEVATION (FEET ABOVE MEAN SEA LEVEL)
(116.7) DEPTH TO POTENTIOMETRIC ELEVATION BELOW LAND SURFACE.
LINE OF EQUAL POTENTIOMETRIC ELEVATION (FEET ABOVE MEAN SEA LEVEL)
CONTOUR INTERVAL IS 10 AND 20 FEET (DASHED WHERE INFERRED).
ARROWS DENOTE DIRECTION OF GROUNDWATER MOVEMENT.
DATE OF WATER LEVEL MEASUREMENT JULY 16 THROUGH JULY 18, 1980.
PERMIT BOUNDARY
DIVERGENCE OF ANDERSON FROM DIETZ COAL SEAMS
DIVERGENCE OF DIETZ FROM ANDERSON COAL SEAMS
Squirrel Creek
POWERS CORMACK DITCH
BROTHERS
LANDING STRIP
Decker
Squirrel Creek Sch
Gaging Sta
TONGUE
Drill Hole
3630
3610
3590
3570
3550
3530
3510
3490
3470
3460
3450
3440
16
15
14
13
18
21
22
23
24
19
20
27
26
25
30
29
28
33
34
35
36
31
3704.6
(11.5)
3463.9
(229.1)
3468.2
(209.8)
3465.7
(236.5)
3467.7
(446.5)
3466.0
(161.8)
3445.9
(241.7)
3457.2
(116.7)
3460.9
3473.2
(120.1)
3466.4
(188.3)
3467.4
(150.4)
3463.5
(145.5)
3478.5
(128.1)

FIGURE 2-5 By measuring water levels in wells, a map can be constructed that shows the potential "topography" of ground water levels (the level to which water would rise in a well). The level of ground water is indicated in elevations above sea level. Arrows indicate the direction of ground water flow.

TABLE 2-6

Nitrate and Ammonia Concentrations in Squirrel Creek (mg/l)

Nitrogen Source	Annual	March-Aug	Sept-Feb
Ammonia, as N (no. samples)[1]	0.30 (33)	0.37 (25)	0.07 (8)
Mean (no. samples)[2]	0.165 (97)	0.184 (83)	0.07 (14)
Range (no. samples)[2]	0.01-1.58 (97)	0.01-1.58 (83)	0.01-0.16 (14)
Nitrates, as N			
Mean (no. samples)[2]	0.21 (97)	0.21 (83)	0.22 (14)
Range (no. samples)[2]	0.01-1.5 (97)	0.03-1.5 (83)	0.02-0.82 (14)

[1] Mean 1978-1980 value near the mouth of Squirrel Creek.

[2] For the lower half of Squirrel Creek, 1978-1981.

Livestock waste and ammonia/nitrate-based fertilizer are believed to be the primary source of the high nitrate and ammonia concentrations. From 500 to 2,000 head of cattle winter along Squirrel Creek at the CX Ranch (Earl Smith, Consol, oral com., January 1984).

Upstream of the permit boundary, Squirrel Creek water is used for watering stock and watering the lawns of the CX Ranch headquarters. Downstream of the ranch headquarters, it is used for watering stock and flood irrigating about 260 acres of alfalfa beside the minesite. Numerous impoundments on tributaries to Squirrel Creek also collect runoff for stock watering. These impoundments generally are dry by late summer.

Two stock ponds on tributaries to Squirrel Creek lie within the 12-year permit area. The ephemeral draw draining the southern extreme of the permit area contains a third stock pond. A fourth pond lies in Dry Creek, just above the stream's confluence with Squirrel Creek, outside the 12-year permit area.

The U.S. Geological Survey maintains two Tongue River gaging stations near the Tongue River Reservoir. One station is located 1 mile north of the Wyoming-Montana state line, or about 4 miles downstream of the confluence of Squirrel Creek and the Tongue River. The other station is located one-half mile downstream of the Tongue River Dam, about 15 river miles below the state line station. The drainage area increases from 1,477 square miles at the state line to 1,770 square miles at the dam station. Despite the 20-percent increase in drainage area, which accounts for Squirrel, Pond, Pearson, Spring, Monument, Leaf, Deer, Badger, and Prairie Dog creeks, the flows at the two stations are similar (table 2-7). Mean annual flow below the dam is lower than would be expected based on flows at the state line station and the increased drainage area. Evaporation and bedrock ground water losses in the Tongue River Reservoir are at least in part responsible for this condition.

Water in the Tongue River is very hard and of the calcium-bicarbonate type. TDS concentrations range from about 200 mg/l during high flows to about 1,300 mg/l during low flows. The median dissolved solid concentration at the Wyoming-Montana USGS gaging station from 1976 to 1981 was 480 mg/l (Van Voast and Thompson, 1982, p. 7). Even though the water is rated as having a medium flood-irrigation salinity hazard, salinity has not appreciably restricted its use for irrigation, the water's primary use both up- and downstream of the reservoir.

Historically, the Tongue River has had ammonia, nitrate, and phosphorus concentrations high enough to cause occasional nuisance algal blooms in the Tongue River Reservoir. Since 1983, however, nitrate and ammonia concentrations in Tongue River water have dropped appreciably, principally due to changes in Sheridan, Wyoming's, sewage treatment system. The changes reduced total nitrogen concentrations in the plant discharge from over 15 mg/l to less than 1 mg/l. Ammonia levels in the river just above the reservoir in turn dropped from an average of about 0.27 mg/l to less than 0.1 mg/l. The influence of the decrease in ammonia and nitrate concentrations on aquatic vertebrates and invertebrates or the frequency and distribution of nuisance algal blooms in the reservoir has not been determined.

Three coal mines—Big Horn Mine, West Decker Mine, and East Decker Mine (fig. IN-2)—now discharge pit water into the Tongue River. The three mines together discharge about 5 cfs, or 1 percent of the river's mean annual flow and 2 percent of the nonpeak flows.

The three existing mines are estimated to have increased the nitrate loading of the reservoir by 22 percent under mean flow conditions and by 40 percent about half the time. Soluble nitrate concentrations from the West Decker, East Decker and Big Horn mines averaged 3.5 mg/l, 1.5 mg/l, and 3.5 mg/l (measured as N) respectively. Soluble nitrate concentrations in the river have averaged less the 0.1 mg/l since early 1983.

The increased nitrate concentrations in the mine discharge water probably result largely from exposure of ground water to air. The ground water naturally contains high amounts of total nitrogen that do not show up during analysis of filtered water. Most of the nitro-

TABLE 2-7

Tongue River Flow Rates (cfs)

	State Line	Tongue River Dam
Mean	496[1]	459[3]
50-percent flow	254[2]	267[4]

Source: Unpublished statistical analysis, U.S. Geological Survey, Water Resources Division, Helena, Montana.

[1] The mean annual discharge at the state line gaging station between 1961 and 1982 was 496 cubic feet per second (cfs).

[2] The flow in the river between 1961 and 1982 at the state line station was equal to or less than 254 cfs 50 percent of the time.

[3] The mean annual discharge between 1940 and 1982 at the dam station was 459 cfs.

[4] The flow in the river at the dam station between 1940 and 1982 was equal to or less than 267 cfs 50 percent of the time.

gen is bound to small suspended particles that are removed before analysis by filtration through a 0.45-micron filter. (For more detail, see technical analysis available on request from the Department of State Lands.) Some of the particle-bound nitrates are believed to be released in soluble form when the ground water is exposed to oxygen (Hem, 1970, p. 180), leading to the marked increase in soluble nitrates in mine discharge water.

Another possible source of inorganic nitrates in the mine discharge water is runoff from reclaimed lands. Two conditions might account for the elevated nitrates in runoff water: (1) ammonia-nitrate fertilizers applied during reclamation (Owens, Edwards, and Van Keuren, 1984), and (2) redistributed topsoil releasing soluble nitrates to surface waters (Cameron and Wild, 1984).

Ammonium-nitrate/fuel-oil (ANFO) explosives used in blasting coal and overburden does not appear to be the major nitrate contributor, as had been suspected. Spoil water samples at the West and East Decker Mines generally contain concentrations of nitrate (0.1 mg/l) and ammonia (2.0 mg/l) similar to concentrations in surrounding ground water. One spoil well at the West Decker Mine did, however, contain 32 mg/l nitrate (as N), well above any concentrations found in undisturbed ground water. Such a nitrate level indicates that unexploded ANFO may in part be responsible for elevated nitrates in mine water.

The existing mines are also adding to the Tongue River's ammonia load. Discharge water from the West Decker, East Decker, and Big Horn mines averaged 2.0, 0.85, and 3.5 mg/l of ammonia, while Tongue River ammonia levels since early in 1983 have averaged less than 0.1 mg/l. Although ground water and the mine discharge water contain about the same amount of ammonia, the quantity of water now reaching the river is significantly greater than before mine development. Before mining, ground water flow through the undeveloped minesites reaching the river was estimated to be about 0.2 cfs (Van Voast and Thompson, 1982). Today, the three mines' discharge averages over 5 cfs. (Note: To date, the Spring Creek Mine has not discharged any water.) The tenfold increase in flow is the primary reason for the predicted increase in ammonia loads for the river.

The mines are not a source of phosphorus loading in the Tongue River or reservoir, because their discharge water contains phosphorus concentrations similar to concentrations in recieving waters.

ALLUVIAL VALLEY FLOORS

The Department of State Lands has determined that the Squirrel Creek valley next to the 12-year permit area is an alluvial valley floor (a valley bottom underlain by stream-laid deposits, holding a stream where water availability is sufficient for subirrigation or flood irrigation agriculture). The valley meets certain criteria established by Congress in the Surface Mining Control and Reclamation Act of 1977, which precludes mining of valley bottom lands that provide a significant portion of a ranching or farming unit's agricultural production. The act further prohibits mining from damaging the essential hydrologic functions (water quality and quantity) responsible for the valley's increased vegetative production.

SOILS

The soils of the CX Ranch vary widely in their depth, texture, color, profiles, morphology, coarse fragment content, and salt and sodium levels. This diversity reflects the variability of topography, parent materials (fig. 2-6), vegetation, and past land uses.

A total of 29 soil series have been identified and placed into 41 mapping units at the CX Ranch. Four miscellaneous land types have also been identified and mapped. For ease of discussion, the soil mapping units have been placed into five major soil groups, based on similarities in parent material, topographical position, and to some extent, texture:

- Alluvial soils
- Loamy and silty residual soils
- Sandy residual soils
- Alluvial and residual soil complexes
- Loess (wind-deposited) soils

The location of these soil groups within the proposed 12-year permit and disturbance areas is shown on figure 2-7. For a complete listing of the mapping units proposed for disturbance, as well as the amount of soil by unit proposed for salvage, see chapter 3, Soils, table 3-8.

ALLUVIAL SOILS

The alluvial soils group covers about 30 percent of the proposed 12-year permit area and about half the proposed disturbance area. (Note that the disturbance area is much smaller than the permit area.) The group includes deep soils that developed in alluvium (water-deposited material) and colluvium (material which has moved downhill and accumulated at the base of steep slopes as a result of gravity).

The deep soils developing in alluvium and colluvium vary widely in physical and chemical characteristics and the degree of soil development. The soil characteristics are determined largely by the nature of the materials from which the soils formed, the manner in which these materials were sorted and deposited, and the

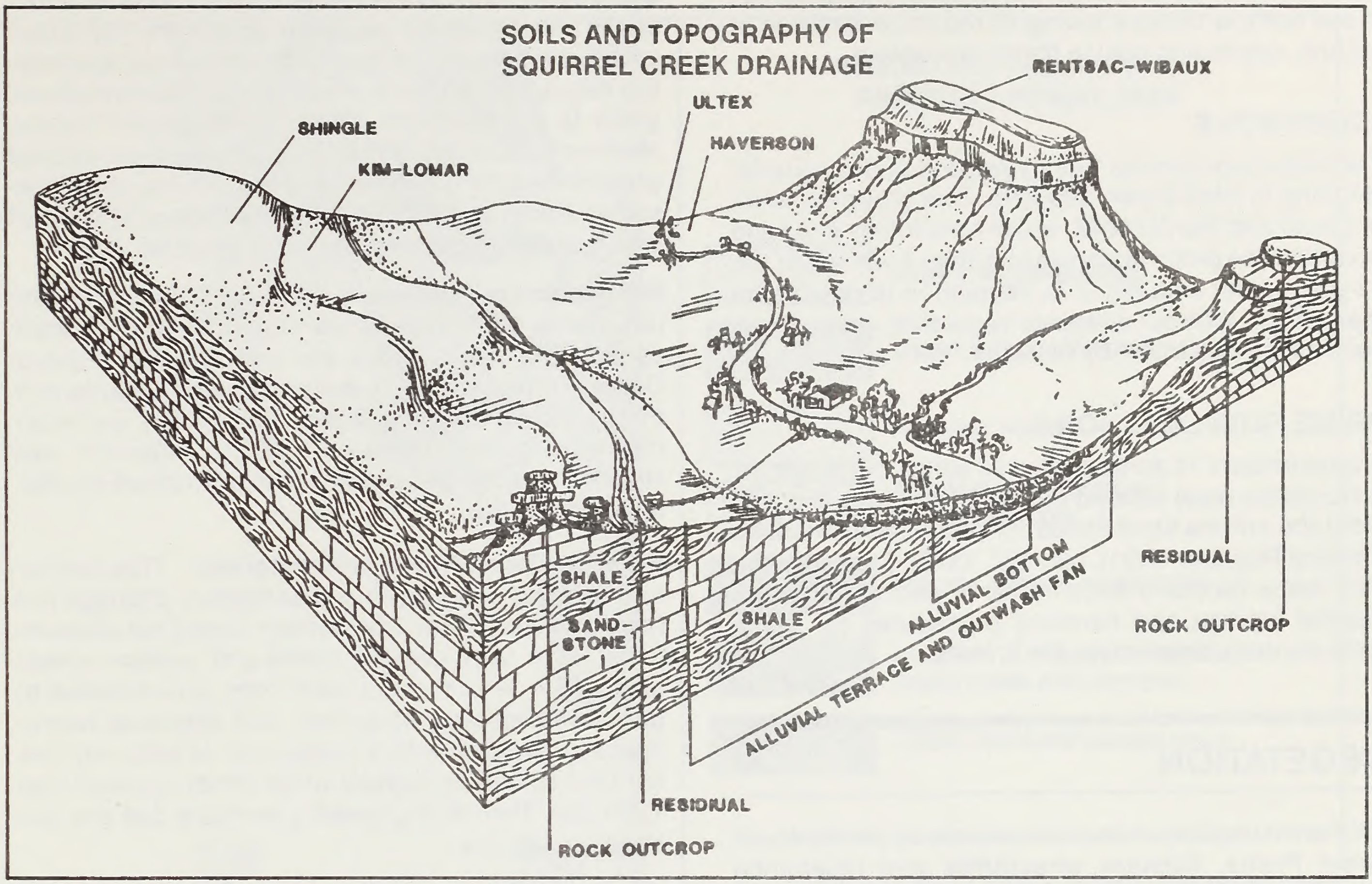


FIGURE 2-6 Soils vary with a variety of factors, especially the topography and the material from which the soils formed. Shown here are seven of the 29 soil series mapped in the CX Ranch 12-year permit area.

type of environment in which the soils developed. The deep, well-developed soils that formed from fine-textured alluvial parent material include the Bolcar, Colbar, Delth, Heldt, Lohmiller, Wolruth, and Thurlow. Deep, medium-textured soils include the Prell, McRae, Haverson, Corkim and Fort Collins soils. Examples of colluvial soils include the Remm soils, formed in material derived from sandstone, and the Kim and Lomar soils, formed in material originally derived from shale and siltstones.

The alluvial soils occur mainly in three parts of the permit area—at the north end, south end, and in the center (fig. 2-7). Plants commonly associated with the group include western and bluebunch wheatgrasses and needle-and-thread, intermixed with greasewood and silver sagebrush on river terraces and drainage bottoms.

LOAMY AND SILTY RESIDUAL SOILS

The loamy and silty residual soil group consists of shallow and very shallow soils developing in place over weakly consolidated siltstone and shale. The group, consisting mainly of Shingle soils, covers about 40 percent of the proposed 12-year permit area and about 30 percent of the proposed disturbance area. These soils typically have silt loam to silty clay loam textures. The most common vegetation on these medium- to fine-textured soils includes big sagebrush and western wheatgrass.

SANDY RESIDUAL SOILS

Rentsac, Wibaux, Lenoy, Eltass, Nelson, and Tassel are examples of sandy residual soils in the 12-year permit area that are developing (in place) over sandstone. These loamy fine sand-textured to sandy loam-textured soils occupy about 20 percent of the 12-year permit area and about 5 percent of the proposed disturbance area. The group appears sporadically throughout the permit area. Vegetation commonly found in association with these soils includes big sagebrush, bluebunch wheatgrass, and needle-and-thread.

ALLUVIAL AND RESIDUAL SOIL COMPLEXES

This group consists of alluvial and residual soils that occur in complex patterns on the landscape that cannot be mapped separately at the 1:4,800 map scale. These soils occupy about 8 percent of both the proposed 12-year permit and disturbance areas. As shown in figure 2-7, these complexes are generally found between units of residual and alluvial soils. Vegetation on these units is diverse, owing to the large variation in texture, depth, and coarse fragment content.

LOESS SOILS

The loess (pronounced "luss") group includes soils developing in wind-blown deposits. This group consists of Dwyer and Yewder soils, which have loamy fine sand textures. The group occupies less than 1 percent of the 12-year permit area (fig. 2-7). Vegetation is variable on these soils. Without adequate vegetative cover, these soils are eroded easily by the wind.

PRIME FARMLAND SOILS

Approximately 14 acres of alluvial soils (1.4 percent of disturbance area) located in the railroad loop (fig. 2-7) meet the criteria established for prime farmland soils (Federal Register 43(21), part 657, 1978). These are the only prime farmland soils in the 12-year permit area. Special salvage and handling procedures for these soils are discussed in chapter 3, Soils.

VEGETATION

CX Ranch vegetation is characteristic of the Northern Great Plains. Western wheatgrass and bluebunch wheatgrass are the two dominant grasses. Big sagebrush, silver sagebrush, and greasewood are the major shrub species. On some slopes, ponderosa pine and Rocky Mountain juniper are found in association with the grasses and shrubs. A discontinuous, narrow band of deciduous woodland, visually dominated by box elder and plains cottonwood, grows along the margins of Squirrel Creek. Historical land use patterns (e.g., grazing, farming) have altered some of the natural communities to what they are today.

CX RANCH PLANT COMMUNITIES

A total of 321 species have been identified within 19 different plant communities (including agricultural types) at the CX Ranch (Consolidation Coal Company, 1984, vol. 13). Some of these communities would not be disturbed under the proposed 12-year plan. A brief description of common plant communities follows.

Big Sagebrush/Bluebunch Wheatgrass. Big sagebrush, consisting of 20.1 percent of all plant cover, is the dominant shrub in this community. The only other shrub found with greater than 0.5 percent coverage is skunkbush sumac. Bluebunch wheatgrass is the dominant grass, commonly found with prairie junegrass and needle-and-thread. Productivity for the community averages 617 pounds per acre (ppa), including 43.9 percent from grasses and 37.9 percent from shrubs.

Big Sagebrush/Western Wheatgrass. This community is found primarily on gentle slopes and flat areas, usually on benches and bottoms of drainage systems. Big sagebrush is the common shrub; western wheatgrass is the dominant grass. Other shrubs include shadscale saltbush and silver sagebrush; associated grasses include green needlegrass, brome, and thickspike wheatgrass. Productivity totals about 975 ppa, of which shrub production makes up about 64 percent.

Big Sagebrush/Needle-and-Thread. This community is found on slight to moderate slopes without regard to aspect. Big sagebush is the only dominant shrub. Common understory grasses include needle-and-thread, blue grama, bluebunch wheatgrass, and western wheatgrass. Threadleaf sedge, plantain, and Hoods phlox are also present. Average annual productivity is 553 ppa.

Silver Sagebrush/Western Wheatgrass. This community is found on terraces and secondary drainage bottoms on soils formed from stream-deposited alluvium. Silver sage (22.7 percent cover) and western wheatgrass (55.7 percent cover) dominate, accompanied by green needlegrass, bluegrass, and Japanese brome. Species diversity in this community is relatively low, but productivity is highest of all shrub communities: 1,834 ppa. Perennial grasses contribute 545 ppa and shrubs 1,146 ppa.

Greasewood/Western Wheatgrass. The greasewood/western wheatgrass community is located on level to gently sloping terrain, in basins of ephemeral drainages, and on terraces above Squirrel Creek. Saline and alkaline soil conditions are often present. Greasewood is the dominant shrub and big sagebrush a common associate. Western wheatgrass is the dominant grass; minor associates include blue grama and Sandberg bluegrass. Average productivity is about 1,034 ppa—378 ppa from shrubs, 341 ppa from perennial grasses, and 315 ppa from annual grasses and forbs.

Breaks. The breaks type is found on steep to very steep slopes that are primarily south-facing. Common shrubs include big sagebrush, shadscale saltbush, nuttall saltbush, greasewood, skunkbush sumac, and rubber rabbitbrush. Grasses that predominate include bluebunch wheatgrass and needle-and-thread, which grow with Indian ricegrass and thickspike wheatgrass. Total annual productivity is about 699 ppa, including 444 ppa from shrubs and 203 ppa from grasses.

Native Grassland Communities. The native grassland types include four communities: western wheatgrass, bluebunch wheatgrass/broom snakeweed, needle-and-thread/blue grama, and prairie sandreed. The western wheatgrass community produces an average 734 ppa, 72 percent from perennial grasses. The bluebunch wheatgrass/broom snakeweed community

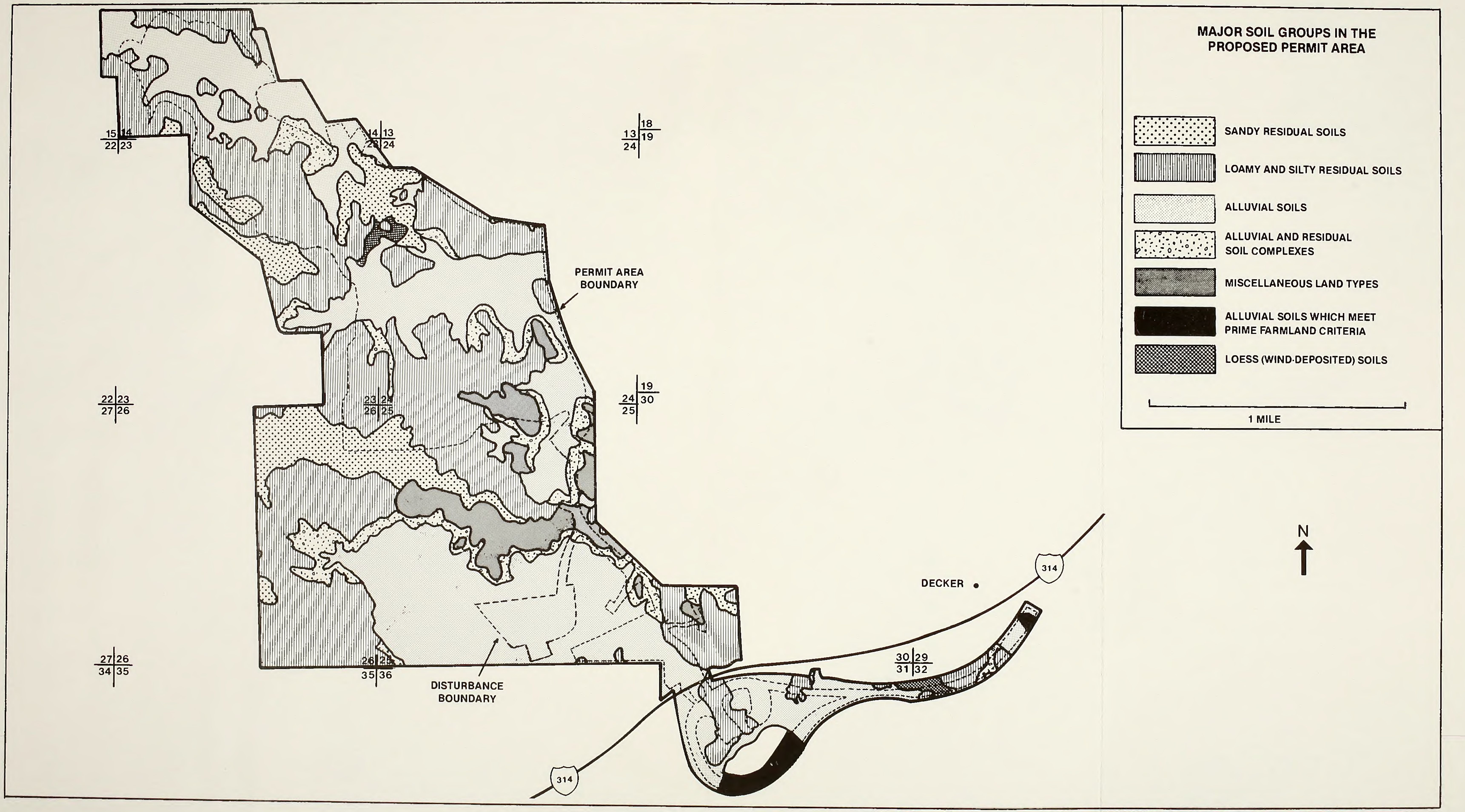


FIGURE 2-7 A complex mosaic of 29 soil series covers the proposed 12-year permit area. These series can be divided into five groups based on a number of similarities. Also included in the 12-year permit area are miscellaneous land types (such as buildings) and prime farmland soils (designated for special treatment by law).

produces 455 ppa; the needle-and-thread/blue grama community produces 390 ppa; and the prairie sandreed community produces 747 ppa.

Rocky Mountain Juniper/Bluebunch Wheatgrass. This community, which is found on steep slopes and at the head of drainages, is the most common woodland community in the area. Soils tend to be shallow. Juniper density averages 315 stems per acre. Big sagebrush is the dominant shrub, although rubber rabbitbrush is also present. Bluebunch wheatgrass is the dominant grass. Total understory production (362 ppa) is split between shrubs (148 ppa) and grasses (126.6 ppa).

Ponderosa Pine/Bluebunch Wheatgrass. The ponderosa pine/bluebunch wheatgrass community, uncommon on the CX Ranch, grows only on north slopes with moderate amounts of moisture. Ponderosa pine is the dominant tree species, bluebunch wheatgrass is the most common grass, and big sagebrush is the only shrub species present.

Wooded Riparian. The wooded riparian community occurs as a discontinuous narrow band along the alluvial bottom of Squirrel Creek. Green ash, willow, and box elder are the most common tree species, accompanied occasionally by plains cottonwoods. The community tends to have many species and a well-developed understory, including shrubs such as woods rose, poison ivy, gooseberry, and snowberry, and dominant grasses such as Kentucky bluegrass, creeping wildrye, and reed mannagrass. Understory production totals about 1,230 ppa, highest of all woodland communities.

Wetland Communities. Two wetland communities are present: cordgrass and cattail. Both types grow in seasonal overflow areas along Squirrel Creek. The cattail community is dominated by cattail, which accounts for 90 percent of the cover. The cordgrass community, in slightly dryer terrain, is dominated by prairie cordgrass.

Improved Pasture. This community type is found in deep soils along the valley floor on level and gently sloping areas. The community has very low species diversity, which depends on the age of the pasture. Newer fields include monocultures of planted species and older fields include increasing numbers of invading native plants. The major grass species is crested wheatgrass, which is associated with wildrye, alfalfa, Japanese brome, and cheatgrass brome. Average annual productivity is about 892 ppa.

Hayland. The hayland areas are located on a terrace above the Tongue River 100-year floodplain. Most of these areas are irrigated and classified as prime farmland. The vegetation consists primarily of alfalfa and smooth brome, which are introduced species. Average annual productivity is about 7,000 ppa.

RANGE CONDITION AND RECOMMENDED STOCKING RATES

As a general rule, topography and water availability regulate grazing pressure. At the CX Ranch, plant communities near bottoms and on level areas are more heavily grazed than other communities. Communities on moderate to steep slopes with limited forage accessibility show little grazing pressure.

The range condition of the lands proposed for disturbance is fair to excellent. The range trend is improving. The present recommended stocking rate (RSR) for the proposed 12-year disturbance area is about 324 cow-calf units for a one-month grazing period, or about 36 cow-calf units for a nine-month period. The potential RSR for the 12-year disturbance area is about 476 cow-calf units for a one-month grazing period, or about 53 cow-calf units for a nine-month period.

THREATENED AND ENDANGERED PLANTS

Pursuant to section 7 of the Federal Endangered Species Act, the Office of Surface Mining consulted with the U.S. Fish and Wildlife Service for the listed species that could occur in the vicinity of the CX Ranch. The list provided by the U.S. Fish and Wildlife Service (D. Harms, pers. com., December 12, 1984) did not contain any plant species. Therefore, the proposed plan would not affect any Federal threatened or endangered plans.

AQUATIC ECOLOGY

Squirrel Creek and the Tongue River are the only streams near the minesite that flow year-round (fig. IN-2). Squirrel Creek, a perennial tributary of the Tongue River that flows alongside the minesite, has a relatively stable channel composed of gravel, sand, and silt. Field water samples contain abundant and diverse macroinvertebrates (aquatic "bugs"). The macroinvertebrate communities change abruptly between sampling sites and seasons. Klarich and Regele (1980) consider Squirrel Creek to be mildly stressed, but with good biotic quality.

Throughout the year, Squirrel Creek contains a healthy, diverse community of diatoms (single-cell plants containing silica). Near the Tongue River, where cows have muddied and disturbed the creek, diatom diversity decreases. But dissolved oxygen (DO) levels (Consolidation Coal, 1981, vol. 12, p. 12) do not indicate undue nutrient loading, or oxygen depletion during low flow. The lowest dissolved oxygen concentration measured, 73 percent of saturation, is similar to levels in the Tongue River (Consolidation Coal, 1981, vol. 12, p. 13).

The Tongue River is considered an unstressed system with excellent biotic quality (Klarich and Regele, 1980, p. 102). Macroinvertebrate (Klarich and Regele, 1980, p. 102) and algal (Bahls, 1980, p. 26) diversities are good. On the other hand, the Tongue River Reservoir is considered to be mildly eutrophic (rich in nutrients and organic materials) (Whalen, 1979). Since detailed water quality and biological data on both the Tongue River and Tongue River Reservoir have been published elsewhere (Knapton and McKinley, 1977; Bahls, 1980; Klarich, et al., 1980; Klarich and Regele, 1980; Leathe, 1980; Whalen, 1979), these systems will not be discussed further here.

MACROINVERTEBRATES IN SQUIRREL CREEK

Squirrel Creek macroinvertebrates are adapted to the broad range of conditions found in a prairie stream, where suspended sediment, streambed composition, temperatures, and water velocities vary widely. As a result, community populations fluctuate significantly during the year. In summer, for example, insects tolerant of decomposable organic wastes and poor water quality dominate. Species intolerant of poor water quality, including *Microcylloepus pusillus, Diamesa spp., Microspectra spp., Simulium spp., Hydropsyche spp., and Orthocladius spp.,* are absent or scarce. Diptera dominate winter collections, Trichoptera, spring collections, and Oligochaeta, Megaloptera, Gastropoda and Coleoptera, fall collections.

Macroinvertebrate species are moderately abundant and diverse in Squirrel Creek, indicating that the macroinvertebrate communities are healthy. The average number of species collected during 1979 was 24, ranging from 19 to 38. The average Shannon-Weaver diversity index was 2.9, ranging from 2.2 to 3.8 (Consolidation Coal, 1981, vol. 12, p. 23). (The Shannon-Weaver index measures the amount of diversity in a plant or animal community.) For comparison, clean waters are reported (Wilhm, 1970, p. R223) to have from 11 to 54 species and a Shannon-Weaver index from 2.6 to over 4. Hence, even though Squirrel Creek water quality declines during summer and is poorer downstream near the Tongue River, the macroinvertebrate community appears little different from communities in other streams in southeastern Montana.

PERIPHYTON IN SQUIRREL CREEK

Periphyton, the community of microorganisms growing on submerged surfaces, includes many kinds of algae. In field samples of Squirrel Creek, diatoms usually dominated at all sampling sites, an indication that the stream is relatively undisturbed and unpolluted (Consolidation Coal, 1981, vol. 12, p. 33; Montana Department of State Lands and U.S. Forest Service, 1982, p. 3-41). Species of *Achnanthes,* indicators of high concentrations of dissolved oxygen, were found in all samples. Many of the other common species found, however *(Navicula viridula var. avenacea, Navicula gregaria, Nitzschia dissipata, Nitzschia frustulum, Rhoicospheria curvata, Gomphonema olivaceum and Cocconeis pediculus),* are tolerant of moderate amounts of nutrients and salts (Lowe, 1974).

Abundant and diverse periphyton communities, like macroinvertebrate communities, generally indicate high water quality. In Squirrel Creek, periphyton diversity indices ranged from 1.46 to 4.45 and averaged 3.45. The number of species collected varied from 29 to 61. For comparison, Bahls (1979) found a diversity index between 3 and 4, and an average of 25 to 40 different species in unpolluted Montana streams. This is further evidence of the generally unpolluted quality of Squirrel Creek.

The sampling site farthest upstream on Squirrel Creek yielded the highest diversity index and number of diatom species. Degradation of water quality due to contamination or disturbance by cattle, especially during the summer months, may explain the decrease in values downstream. Growth measurements of periphyton appear to substantiate this: Biomass (plant matter) accumulation rates (ranging from 21.6 to 160.4 mg/m^2/day) and cholorophyll *a* (plant pigment accrual rates (ranging from 0.03 to 6.65 mg/m^2/day) indicate moderate nutrient concentrations, or in other words that the stream is moderately mesotrophic (moderately rich in nutrients and organic materials). The autotrophic index, the ratio of biomass to chlorophyll *a* is high, ranging from 387 to 2,149. This indicates poorer water quality as a result of organic enrichment, possibly from cattle (Consolidation Coal, 1981, vol. 12, p. 57).

Chemical analyses, on the other hand, do not indicate cattle contamination. Neither nitrogen nor phosphorous levels common in waters contaminated by cattle were found (Knapton and McKinely, 1977, p. 75). Moreover, biochemical oxygen demand, another measure of organic pollutant concentrations, was low (Consolidation Coal, 1981, vol. 12, p. 42). The nitrogen and phosphorus could be tied up in either stream sediments or plants. It is not clear what effect cattle are having on the water quality of Squirrel Creek.

FISHERIES

Squirrel Creek, a small, perennial tributary of the Tongue River, flows along the northeast side of the minesite. It is the only perennial creek within the CX Ranch.

In three sections of Squirrel Creek, electroshocking was used to determine what species of fish are present (table 2-8). Minnows made up 54 percent and suckers 43 percent of the total sample (Consolidation Coal Co., 1981, vol. 12). An undetermined number of smallmouth bass, three rock bass, and three catfish were taken at the mouth of Squirrel Creek. The presence of smallmouth bass during June suggests that the mouth may be a spawning ground. Although this has not yet been documented, Consol would conduct further studies prior to mining. Angling opportunities in Squirrel Creek are limited compared to the nearby Tongue River and Tongue River Reservoir.

TABLE 2-8
Species List, Squirrel Creek Fish Survey, 1978–1980

Family	Species
Minnow (Cyprinidae)	Carp *(Cyprinus carpio)* Flathead chub *(Hybopsis gracilis)* Lake chub *(Couesius plumbeus)* Fathead minnow *(Pimephales promelas)* Longnose dace *(Rhinichthys cataractae)*
Sucker (Catostomidae)	Longnose sucker *(Catostomus catostomus)* White sucker *(Catostomus commersoni)* Mountain sucker *(Catostomus platyrhynchus)*
Catfish (Ictaluridae)	Black bullhead *(Ictalurus melas)* Stonecat *(Notorus flavus)*
Sunfish (Centrarchidae)	Smallmouth bass *(Micropterus dolumieui)* Rock bass *(Amblophites rupestris)*

Source: Consolidation Coal Company, 1984, vol. 12.

Electrofishing and gill-netting were used to sample fish populations in the Wyoming portion of the Tongue River (Wesche and Johnson, 1979). Rough fish and other species of little interest to anglers made up most of the catch at the state line sampling section (table 2-9). The only game fish taken at this site, roughly 1 mile upstream from Consol's facilities site, was the sauger. However, walleye *(Stizostedion vitreum)*and northern pike *(Esox lucius)*from the Tongue River Reservoir migrate through this reach during spring spawning (Riggs, 1978; Wesche and Johnson, 1979). Fishing pressure on the river is light compared to the nearby Tongue River Reservoir.

The Tongue River flows into the Tongue River Reservoir about 12 miles downstream from Consol's facilities site. Sampling with gill nets revealed that fishes acceptable to anglers (northern pike, bullhead, catfish, bass, crappie, walleye, and perch) constituted over 80 percent of the total catch (table 2-10) (Stewart, 1984). Shorthead redhorse was the most common rough fish species taken. Although the reservoir is lightly fished compared to other cool-water, northern-latitude lakes (Elser, 1983), it provides most of the fishing in the Decker area.

Pursuant to section 7 of the Federal Endangered Species Act, the Office of Surface Mining consulted with the U.S. Fish and Wildlife Service for the listed species that could occur in the Squirrel Creek vicinity. The list provided by the U.S. Fish and Wildlife Service (pers. com., December 12, 1984) did not contain any fish species. Therefore, mining in the permit area would not affect any Federal threatened and endangered fish.

WILDLIFE

The topography of the minesite is diverse. Flat to gently sloping terraces rise to steep, eroded slopes, gently sloping uplands and ridgetops. Within the minesite are five wildlife habitat types (table 2-11). The sagebrush/grassland type is the most common, covering two-thirds of the 12-year permit area. The 33-year plan area and proposed Wolf Mountain minesite contain similar habitats. (Note: The information here and below comes from two sources: the CX Ranch Mine permit application [Consolidation Coal Company, 1984, vol. 11] and the Wolf Mountain Mine permit application [Kiewit Mining and Engineering Company, 1981, vol. 10].)

BIG GAME

Three big game species—mule deer, pronghorn antelope, and white-tailed deer—have been observed on the Squirrel Creek study area. (The study area includes the CX Ranch Mine 33-year area, the proposed Wolf Mountain Mine permit area, and a two-mile-wide band around both.) Mule deer are most common of the three big game species. (See appendix E for scientific names of wildlife species.)

TABLE 2-9
Fish Species Captured in the Tongue River Near the Montana-Wyoming Border, Spring, 1978

Family	Species	Number Captured	Mean Average Length (Inches)
Cyprinidae	Carp *(Cyprinus carpio)*	5	20
Catostomidae	Northern redhorse *(Moxostoma macrolepidotum)*	15	12
Catostomidae	White sucker *(Catostomus commersoni)*	4	11
Ictaluridae	Stonecat *(Notorus flavus)*	1	9
Centrachidae	Rock bass *(Amblophites rupestris)*	5	5
Percidae	Sauger *(Stizostedion canadense)*	10	18

Source: Wesche and Johnson, 1979.

TABLE 2-10

Fish Species Captured in the Tongue River Reservoir Twelve Gill Net Sets, August, 1983

Family	Species	Percent of Total Catch[1]	Mean Average Length (Inches)
Esocidae	Northern pike *(Esox lucius)*	0.3	28
Cyprinidae	Carp *(Cyprinus carpio)*	4.0	18
Catostomidae	Shorthead redhorse *(Moxostoma macrolepidotum)*	11.6	11
	White sucker *(Catostomus commersoni)*	3.2	14
	Longnose sucker *(Catostomus catostomus)*	0.1	10
Ictaluridae	Yellow bullhead *(Ictalurus natalis)*	3.0	9
	Channel catfish *(Ictalurus punctatus)*	0.3	12
Centrachidae	Smallmouth bass *(Micropterus dolumieui)*[2]	2.0	10
	Black crappie *(Pomoxis nigromaculatus)*	0.6	8
	White crappie *(Pomoxis annularis)*	55.6	9
Percidae	Walleye *(Stizostedion vitreum)*	0.4	17
	Yellow perch *(Perca flavescens)*	18.9	7

Source: Stewart, 1984.

[1] Sample size was 698 total fish.

[2] Percentage of smallmouth bass in the population is probably underestimated by gill net data (Stewart, 1984).

TABLE 2-11

Wildlife Habitat Types Coverage in the CX Ranch Mine Proposed 12-Year Permit Area

Wildlife Habitat Type	Corresponding Vegetation Community Types	Approximate Permit Area Coverage
Sagebrush/grassland	Big sagebrush/Western wheatgrass Big sagebrush/Bluebunch wheatgrass Silver sagebrush/Western wheatgrass	67%
Cultivated land	Improved pasture Hayland	11
Perennial grassland	Western wheatgrass Bluebunch wheatgrass/Broom snakeweed	10
Breaks	Breaks	8
Coniferous woodland	Rocky Mountain juniper/bluebunch wheatgrass Ponderosa pine/Bluebunch wheatgrass	4
Deciduous streambank	Cordgrass Cattail Wooded riparian	1

Source: Consolidation Coal Company, 1984, vol. 13.

Mule deer use a variety of habitat types, although they spend more time in some types than in others as the seasons change. The most frequently used type is the sagebrush/grassland habitat, used by over half of all mule deer observed during each of the four seasons from fall 1979 through summer 1980. Such use reaches a high in winter, when 70 percent of all mule deer observed were in this type.

Other habitat types are used far less often by mule deer. In 1979 and 1980, use of the breaks type increased in fall, to 14 percent of all animals observed, and in winter, to 15 percent observed. Coniferous woodland use also increased in the fall, to 11 percent observed, and in winter, to 13 percent observed. Perennial grasslands were used mostly during spring (12 percent of deer observed). Use of the cultivated type peaked in summer (32 percent of those observed) and fall (16 percent observed). During summer and fall, an abundance of deer were sighted in alfalfa fields and pastures; deer were frequently noted during early morning moving from cultivated lands into the breaks type, which provides daytime cover.

Along with changing their habitat types with the season, mule deer change their topographic location. During 1979 and 1980, the deer mostly used benchlands and coulee bottoms during spring and summer. They tended to use steeper slopes during fall and winter.

The major mule deer range during the severe winter of 1977–78 extended along the slopes and ridges northeast of Squirrel Creek, an area covering a small portion of the proposed Wolf Mountain Mine. Ten observations of single does in June suggest that fawning grounds probably lie in heavy sagebrush cover at coulee heads and in riparian (streamside) grasslands along Squirrel Creek. September 1980 spotlight counts indicated high productivity: 87 fawns per 100 does.

Pronghorn antelope use the Squirrel Creek study area infrequently. A herd moves through portions of the area between winter ranges on Spring Creek (to the north) and Tanner Creek (to the west) (fig. IN-2). During winter 1977–78, the herd used the western end of the permit and 33-year areas. Studies near Decker, Montana, indicate that most pronghorn use big sagebrush habitats (Amstrup, 1978). However, the study found that pronghorn often chose grasslands for bedding due to superior visibility.

Twenty-two white-tailed deer were sighted from November 1979 to November 1980 along Squirrel Creek, primarily in deciduous streambank and cultivated habitat types. The deer, using Squirrel Creek as both habitat and as a winter travel route, range between CX Ranch headquarters and the Tongue River.

OTHER MAMMALS

Deer mice, masked shrews, white-footed mice, and bushy-tailed woodrats have been trapped during spring on the 33-year plan area. Trapping has been most successful (9.3 animals per 100 trap nights) in the breaks habitat type. Deer mice, the most abundant species, have been trapped in most habitat types. Although least chipmunks and thirteen-lined ground squirrels have not been trapped, they have been commonly observed.

Three black-tailed prairie dog towns lie within the study area: one in the proposed 12-year permit area, one within the proposed Wolf Mountain Mine, and one just west of the 33-year area. All three lie in flat, sagebrush/grassland habitat type. Their size varies from less than 1 to over 12 acres.

Beavers, muskrats, mink, striped skunks, and raccoons live in riparian areas. Badgers, coyotes, pocket gophers, long-tailed weasels and little brown bats use various habitats. Bobcats and yellow-bellied marmots have been observed, though infrequently, near rocky outcrops. Pine squirrels use coniferous woodlands. Other mammals observed in the area include white-tailed jackrabbits and, more frequently, desert cottontails.

BIRDS

Upland Game Birds

Four species of upland game birds—sage grouse, sharp-tailed grouse, ring-necked pheasant, and gray (or Hungarian) partridge—have been observed on the Squirrel Creek study area.

No sage grouse strutting grounds lie within the 33-year area or the proposed Wolf Mountain minesite. However, the Twin Buttes strutting grounds, attended by a maximum of 60 birds in 1980, lies about 0.5 mile west of the 33-year plan area. Many grouse that live in the 12-year permit area throughout the year probably breed at this ground. Additional strutting grounds, attended by a maximum of 25 birds in 1980, lie about 3 miles northwest of the 33-year area.

All sage grouse that have been observed were in the sagebrush/grassland habitat type. Uniformly dense stands of big sagebrush located north of and within both the 12- and 33-year areas provide winter cover.

Sharp-tailed grouse have been seen, infrequently, in the study area. Eighty-five percent of observations have been made in the sagebrush/grassland habitat, although some birds have been sighted in cultivated and deciduous streambank types. No dancing grounds lie within the 12-year permit area, 33-year plan area, or the proposed Wolf Mountain Mine permit area. The closest dancing ground lies about 1.5 miles north of the 33-year area.

Pheasants are common in the study area. Most have been observed within 200 yards of the dense cover along Squirrel Creek.

Two coveys of gray partridge were observed in the winter of 1979 at the eastern tip of the 33-year area in sagebrush/grassland habitat. Little of the habitat partridge prefer—grain fields interspersed with brushy cover (Trueblood and Wiegand, 1971)—lies in the Squirrel Creek study area.

Water Birds

Great blue herons, mallards, and killdeer are the only common summer residents of the Squirrel Creek study area. The herons, recorded feeding along Squirrel Creek during spring and summer, are probably on foraging trips from the rookery at Tongue River Reservoir. Although mallards have been noted year-round on Squirrel Creek, fluctuating water levels and livestock grazing discourage nesting.

Most observations of other waterbirds—Canada geese, blue-winged teal, green-winged teal, redheads, common mergansers, double-crested comorants—have been during spring and fall migrations. Observations made outside the migration periods have been along the Tongue River.

Raptors (Birds of Prey)

Fifteen raptor species have been sighted on the Squirrel Creek study area. Five—golden eagle, prairie falcon, red-tailed hawk, great-horned owl, and American kestrel—nest in or near the 12-year permit area and the proposed Wolf Mountain Mine.

One golden eagle nest site lies within the 33-year area and another lies just outside that area. (Neither lie in the 12-year permit area.) There is also an active nest about 0.75 mile west of the 33-year area. One active nest and one nest site lie less than 1 mile north of the proposed Wolf Mountain Mine. Since 1979, young have hatched in two of these nests. The location of the active nest varies from year to year.

One prairie falcon nest site is located in sandstone outcrops within the CX Ranch Mine 12-year permit area and another in the outcrops of the proposed Wolf Mountain Mine. Prairie falcons nested in the 12-year permit area site in 1975, 1983, and 1984. Great horned owls have nested in the same site in other years. The site in the Wolf Mountain area, last used in 1984, lies along Squirrel Creek. Another nest site, about 1.5 miles north of the proposed Wolf Mountain Mine, was active in 1982 (Roger Burton, Kiewit Mining and Engineering, pers. com., January 15, 1985).

Two red-tailed hawk nests, productive in 1982, are located in trees along Squirrel Creek. One of these nests, along with an unused nest site, lies between the 12-year permit area and the Wolf Mountain Mine.

Great horned owls are common year-round residents of the Squirrel Creek study area. They are opportunistic nesters, taking over magpie and raptor nests and building new nests in trees, hollows, ledges, old buildings, mining cuts, and on the ground (Bent, 1938; Craighead and Craighead, 1956). One owl nest (in the prairie falcon nest site on the 12-year permit area) produced a total of two young in 1982. Another nest in the 33-year area produced four young the same year. Several more breeding territories or inactive nests are located elsewhere in the area.

American kestrels, sighted in all habitats, are the most abundant raptor in the study area. Kestrels nest in woodpecker holes, cavities in pine snags, cliffs, and nest boxes (Lockhart, 1977). Four nests were found during 1980 in the 12- and 33-year areas, while one was in the Wolf Mountain minesite.

Other Birds

Nongame breeding bird surveys were conducted in 1980 in both the 12-year permit area and the Wolf Mountain Mine area. Habitat types sampled included deciduous streambank, sagebrush/grassland, and coniferous woodland. The surveys found that Brewer's sparrows, vesper sparrows, western meadowlarks, and lark buntings are common in sagebrush/grassland types. Diversity and density of birds, however, is highest in riparian types, where, as elsewhere in southeastern Montana, the vegetation is more diverse than in surrounding habitats. In the survey, yellow warblers, common grackles, and red-winged blackbirds were most abundant in the deciduous streambank type.

REPTILES AND AMPHIBIANS

Snakes, lizards, turtles, frogs, and salamanders have been observed in the study area. Prairie rattlesnakes have been observed in most habitat types, with dens reported in rocky areas near Squirrel Creek and Dry Creek. Bull snakes have been commonly observed on roads and in cultivated, sagebrush/grassland, and deciduous streambank types. Garter snakes were occasionally observed in deciduous streambank types and yellow-bellied racers in the sagebrush/grassland, cultivated, and deciduous streambank types.

Sagebrush lizards and short-horned lizards have been seen infrequently in the sagebrush/grassland type and near rocky outcrops. Painted turtles, snapping turtles, chorus frogs, and tiger salamanders have been reported along Squirrel Creek. Rocky Mountain toads have been observed in cultivated areas.

THREATENED AND ENDANGERED SPECIES

Pursuant to section 7 of the Federal Endangered Species Act, the Office of Surface Mining consulted with the U.S. Fish and Wildlife Service for the listed species that could inhabit the CX ranch minesite. The U.S. Fish and Wildlife Service (D. Harms, pers. com., December 12, 1984) responded with a list containing the peregrine falcon, the bald eagle, and the black-footed ferret.

During the winters of 1981 and 1982 five bald eagle observations were made along the Tongue River. The nearest active bald eagle nest is in Wyoming, about 1.5 miles southwest of the 12-year permit area. Several peregrine falcons have been sighted 5 miles south and 8 miles southwest of the 12-year permit area. The three prairie dog towns in the study area were searched for black-footed ferrets. No ferrets or ferret sign were found.

CLIMATE

The semiarid climate at the minesite is typical of the Northern Powder River Basin. Moisture is insufficient to support dense vegetative growth (Critchfield, 1966, p. 168). Precipitation is low, falling primarily during late spring and early summer. Precipitation and temperature exhibit large seasonal and annual ranges. Prevailing wind speeds are low, and surface humidity is moderate.

PRECIPITATION

From 1951 to 1976, total annual precipitation at Decker (2 miles east of the minesite) ranged from 6.5 to 19.4 inches, with an annual average of 12.2 inches (Montana Department of State Lands , 1980, p. 2-9). This is the lowest average of six sites analyzed in the Northern Powder River Basin (U.S. Department of the Interior

[USDI] and MDSL, 1980, p. 2-23). About 47 percent (5.7 inches) falls from April through June; 28 percent (3.4 inches) falls mostly as snow from October through March; and 25 percent (3.1 inches) falls during summer thunderstorms. During the 4-year period of 1973-1977, hail fell only four times.

During a normal year, precipitation in some form would occur on 73 days. The calculated frequency of intense precipitation is similar to that of other areas in eastern Montana: One inch falling in six hours can be expected every two years, and three inches falling in 24 hours every 100 years. Other recurrence intervals are listed in previous EISs (USDI and MDSL, 1980, p. 2-24; MDSL, 1980, p. 2-11).

Effective precipitation (water available for plant growth, soil formation, and erosion) is greatest during April through June (USDI and MDSL, 1980, p. 2-23).

TEMPERATURE

The average temperature is about 43 °F, similar to other areas in the Northern Powder River Basin. January is the coldest month, with temperatures averaging about 20 °F, and July and August the hottest, with temperatures averaging about 90 °F. Average relative humidity is about 63 percent; relative humidity is highest in January, at 76 percent, and lowest in August, at 53 percent.

The freeze-free period ranges from 90 to 100 days. The high temperatures plus low precipitation, however, effectively terminate the growing season by late summer, due to drought-induced dormancy of vegetation (Toy and Munson, 1978, p. 1).

WINDS

During the one-year study period (CDM, 1984), wind speeds were low, averaging 4.4 miles per hour, and show little seasonal variation. Winds from the northwest and west northwest predominate. There are no pronounced seasonal differences in wind direction.

ATMOSPHERIC STABILITY

Atmospheric stability is a measure of vertical air motion. Stable atmospheric conditions tend to suppress mixing. Unstable atmospheric conditions promote mixing, dispersing air pollutants more thoroughly than stable conditions.

The stability class distribution at the minesite (determined by the bulk-Richardson-number method) shows that stable conditions occur 39 percent of the time, neutral conditions, 28 percent of the time, and slightly to extremely unstable conditions, 33 percent of the time.

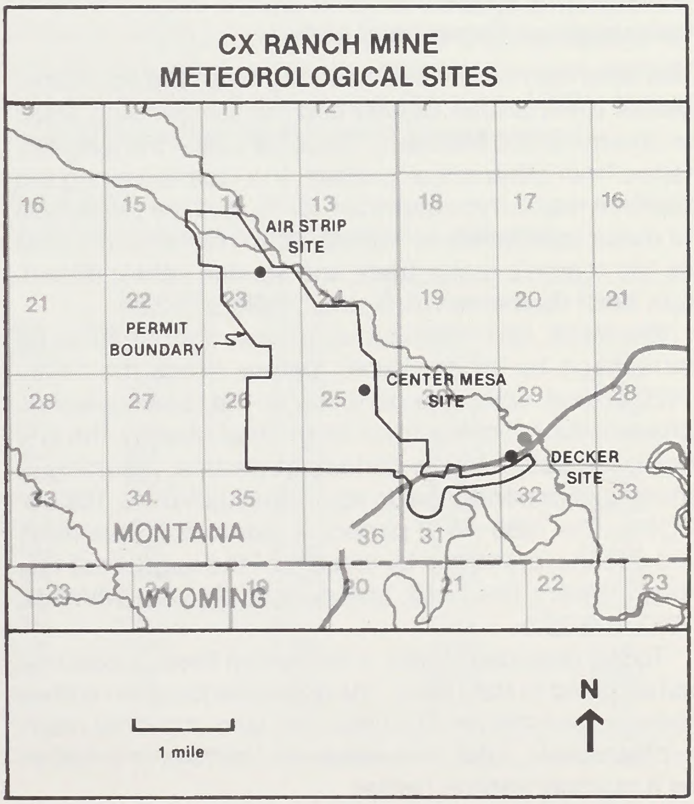
AIR QUALITY

The air quality at the minesite is very good. Total suspended particulate (TSP) concentrations are similar to those in other undeveloped areas of rural eastern Montana (U.S. Department of the Interior and Montana Department of State Lands [USDI and MDSL], 1979, p. 2-36; USDI and MDSL 1980, p. 2-18; MDSL, 1980, p. 2-14). Annual average TSP concentrations measured during a study for Consol's permit application (based on 60 24-hour sampling periods) were 29.9 $\mu g/m^3$ (micrograms per cubic meter) at the Decker meteorological site, 20.4 $\mu g/m^3$ at the Central Mesa site, and 17.6 $\mu g/m^3$ at the airstrip site (fig. 2-8). These levels are well below the Montana Ambient Air Quality Standard annual average of 75 $\mu g/m^3$.

The maximum 24-hour TSP concentrations measured were 93.9 $\mu g/m^3$ at the Decker site, 55.5 $\mu g/m^3$ at the airstrip site, and 54.7 $\mu g/m^3$ at the Central Mesa site. Again, these levels are well below the Montana Ambient Air Quality Standard of 200 $\mu g/m^3$. TSP concentrations were highest at the Decker site, possibly from dust from nearby dirt roads that connect Decker with two gravel pits near the Tongue River.

Two major surface coal mines, Spring Creek to the north and the Decker complex to the northeast, lie

FIGURE 2-8 Consol took meteorological measurements on three sites in or near the proposed 12-year permit area. The data were used to characterize both air quality and climate.



within seven miles of the CX Ranch minesite. The mines do not appear to cause a noticeable increase in TSP concentrations at any of the CX Ranch monitoring sites.

Concentrations of all air pollutants other than TSP, such as sulfur dioxide, carbon monoxide, and nitrogen oxides, are also very low at the CX Ranch. No major sources of these pollutants exist nearby.

TSP concentrations measured at Central Junior High School in Sheridan, Wyoming (fig. IN-2), during the period of September 1, 1981, to September 30, 1982, indicate a potential air quality problem. The Wyoming annual standard (60 $\mu g/m^3$, geometric mean) and 24-hour standard (150 $\mu g/m^3$), which can be exceeded once, were both exceeded. Moreover, the Federal standards (chapter 3, table 3-12) were approached: A geometric mean TSP concentration of 73.5 $\mu g/m^3$ and a second highest TSP 24-hour concentration of 262 $\mu g/m^3$ were recorded. At samplers located farther from downtown, lower TSP concentrations (20 to 30 $\mu g/m^3$) were recorded (Richard Schrader, written com., Division of Air Quality, Wyoming Department of Environmental Quality, January 31, 1983).

ECONOMICS

SHERIAN COUNTY

Industrial and Commercial Activity

The Sheridan urban area has long been the economic center for Sheridan County and the surrounding areas in Wyoming and Montana. Three factors—the long distance from other major centers, the location along the region's major transportation route, and the closeness to major coal reserves—combine to reinforce the area as the region's major trade and service center (Mountain West Research-North, Inc. , 1983, p. 3-258).

Sheridan, like most communities, continues to be influenced by its economic history. Since the 1910–1920 period, when the political, social, and economic characteristics of the town diversified sharply, the city has been subjected to periods of decline, resulting in increased dependence on agriculture (MWR-N, 1983, p. 3-261). The 1950–1970 period, in particular, illustrates the decline, prompted by closure of the sugar beet factory, brewery, flour mill, and railroad tie yard (MWR-N, 1983, p. 3-261).

Today, Sheridan is also a retirement town, a position established in the 1950s. The desirable location and regional reputation of Sheridan has also attracted many professionals, who now reinforce the town's position as a regional service center.

Quantity and Distribution of Employment

A computer model was used to generate much of the economic data for the EIS. (See introduction.) The technique used by the model to project employment growth is called economic (or export) base.The economic base approach assumes that jobs can be divided into two sectors, basic and nonbasic. Basic jobs arise from work shaped by forces outside the area. The basic sector includes tourist-related business, State and Federal government work, and business associated with selling area goods and services outside the region (exporting). Nonbasic jobs arise from work associated with goods and services sold inside an area. Nonbasic has many other names: induced, derivative, secondary, residentiary, and ancillary. The number of nonbasic jobs is believed to be determined by the number of basic jobs.

Basic employment in Sheridan County in 1980 was composed of jobs in trade and services (29 percent), mining (20 percent), agriculture (17 percent), construction (11 percent), government (9 percent), and other industries (14 percent). Nonbasic employment was mainly in the trade and service sectors, which provided nearly 48 percent of the jobs in 1980. Government, providing 27 percent of nonbasic jobs, and construction, providing 13 percent, were next in dominance (MWR-N, 1983, p. 3-223).

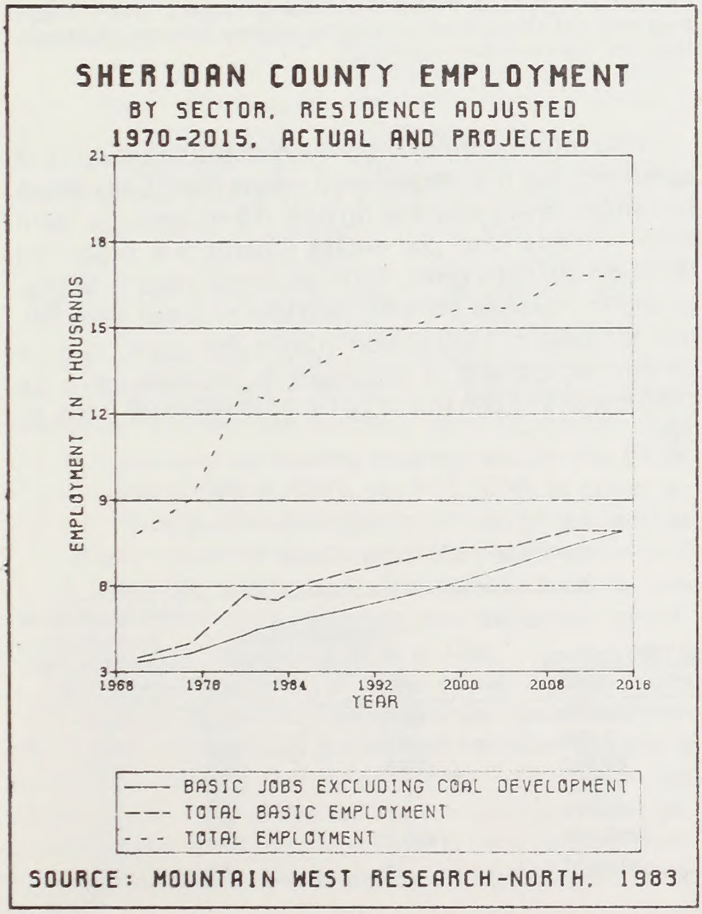
During the 1970s, coal deposits around Decker, Montana, just north of Sheridan, became economic to develop. As a result, Sheridan underwent an economic revival and rapid employment growth (fig. 2-9.) Between 1970 and 1980, total county employment rose 68 percent, led by increases of 670 percent in mining, 200 percent in construction, and 120 percent in transportation, communications and utilities. The increase in service employment was smaller (80 percent), as was the increase in trade employment (50 percent) (MWR-N, 1983, p. 3-216).

In trade and services, the number of nonfarm proprietors increased by 50 percent from 1970 to 1980, reflecting the increasing role of Sheridan as a trade and service center. Meanwhile, the number of farm proprietors remained stable and salaried farm workers increased. The trend of increasing coal-related and nonfarm proprietor employment, together with the stability of agricultural employment, signals a shift away from an economy based on agriculture to one ever more dominated by energy development, trade, and services (MWR-N, 1983, p. 3-216).

Employment growth in Sheridan County has sharply increased the proportion of women employed outside the home. The 1970 labor-force participation rate among women was 31 percent; the 1980 rate stood at 51 percent (MWR-N, 1983, p. 3-218). The rise stems partly from a changed attitude toward working women, and also to a rising number of jobs traditionally held by women and an increase in the number of women in nontraditional jobs (MWR-N, 1983, p. 3-216). The increase in the labor-force participation rate for women slowed the increase in population during the 1970s; that is, had the rate stayed the same, each new job in the county may have raised the population by attracting outside workers.

Just as job growth at the Decker area mines spurred overall Sheridan County employment in the 1970s (fig. 2-9), layoffs at the Decker and Spring Creek mines in 1981 and 1982, combined with the national recession, forced total employment to decline. Between 1980 and 1984, the total number of jobs in Sheridan County dropped from 12,934 to 11,850, down 8.4 percent. Mine employment underwent the largest decrease, falling 24.4 percent, followed by construction employment, falling 22.0 percent, and government employment, declining 7.5 percent. Trade and service employment each fell 4.4 percent and manufacturing employment declined 3.4 percent. Employment in other sectors, such as agriculture, remained relatively stable from 1980 to 1984. (MWR-N, 1985, p. 41).

FIGURE 2-9 Sheridan County employment grew sharply in the 1970s, mostly from an increase in mining employment. Mine layoffs in the early 1980s lowered employment. In the future, employment is expected to climb steadily, though coal-related employment is forecast to decline in the twenty-first century, mostly from the closure of Decker, Spring Creek, and Big Horn Mines.



SOURCE: MOUNTAIN WEST RESEARCH-NORTH, 1983

The forecast of future employment generated by the computer model assumes that both the Decker and Spring Creek Mines will eventually return to full production and employment. Moreover, for this chapter, it is assumed that no new mines would be built. Based on these assumptions, coal-related basic employment is projected to increase throughout the 1980s, reaching a peak of 1,320 in 2000 (MWR-N, 1985, p. 41). Total employment, spurred by the increase in mine jobs and steady growth in other basic employment industries, is projected to peak at 15,991 jobs in 2010, an increase of 24 percent over 1980 and 35 percent over the 1984 low (fig. 2-9).

During the 1990s employment at the Decker Mines will decline, causing coal-related basic employment, according to the assumptions, to decline slightly. Even so, other basic industries, except agriculture, will continue to grow steadily. Overall, total employment will grow, rising 14 percent in the 1990s, compared to 3 percent in the 1980s (MWR-N, 1985, p. 41).

In the first decade of the 21st century, total employment will continue to grow, although more slowly than the in previous 10 years. The increase will stem from employment growth in other basic industries, which will offset, until 2010, the declines in coal-related basic employment. The decline in coal-related employment will be governed by demand for and sale of coal and by related mine schedules. Specifically, assuming full production rates and some additional Federal coal leasing, the Decker and Big Horn Mines will end production about 2005 (Kiewit Mining and Engineering Co., written com., November 2 and 9, 1982). Spring Creek will close around 2010, when total employment in the county is projected to decline slightly (table 2-12 and fig. 2-9). (Due to the downturn in the coal market and the national recession in the early 1980s, these closing dates may be extended several years.)

TABLE 2-12

Forecast of Sheridan County Employment, 1980–2015

	Basic Employment		Total Nonbasic	Total
Year	Coal Related	Total	Employment	Employment
1980	1,014	5,725	7,208	12,933
1981	1,020	5,546	7,047	12,593
1982	866	5,287	6,677	11,964
1983	775	5,306	6,682	11,988
1984	861	5,289	6,561	11,850
1985	960	5,365	6,583	11,948
1986	1,001	5,430	6,589	12,019
1987	1,051	5,653	6,839	12,492
1988	1,084	5,848	7,046	12,894
1989	1,106	5,949	7,124	13,073
1990	1,120	6,049	7,214	13,263
1995	1,148	6,713	7,795	14,508
2000	1,077	7,095	8,068	15,163
2005	633	7,211	8,076	15,287
2010	523	7,543	8,448	15,991
2015	517	7,457	8,353	15,810

Source: Mountain West Research-North, 1983, p. 4-174; 1985, p. 41.

Total employment, at the time the Spring Creek Mine closes, will respond to the coal-related job losses less sharply than to earlier growth, due to the the changing economic base. By the time the coal jobs would be lost, the county's trade and service sector would make up a larger proportion of basic employment and would be more than twice as large as during the 1970s.

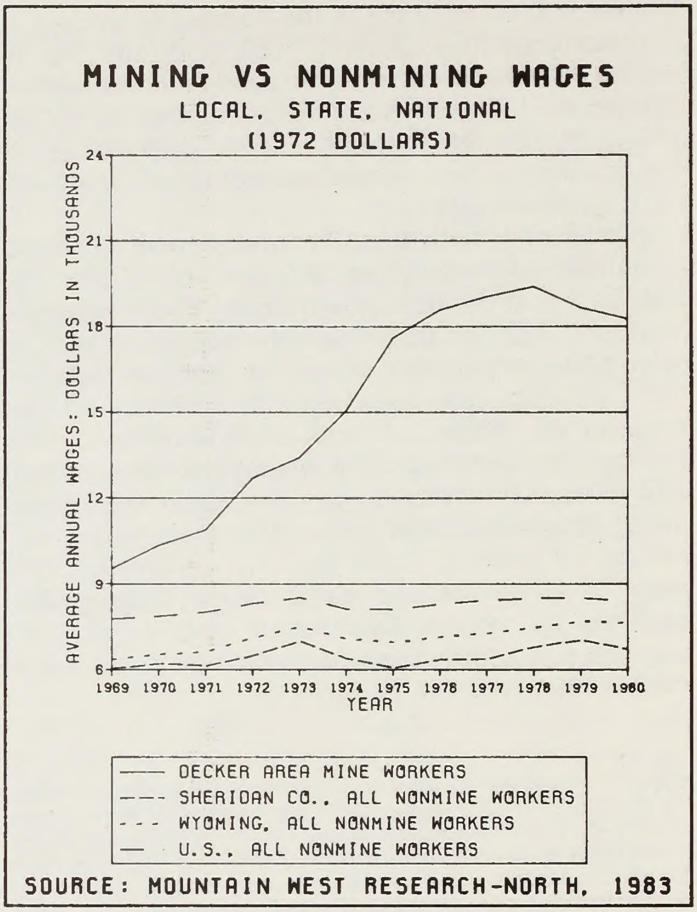
Community and Personal Income

Growth in employment during the 1970s produced growth in personal income in the county. In constant 1980 dollars, total personal income grew from $142 million in 1970 to $266 million in 1980, an increase of 88 percent. Per capita income increased from $7,945 to $10,611, or 34 percent (table 2-13 or MWR-N, 1983, p. 3-225).

All components of personal income increased over the decade (table 2-13). The residency adjustment, which reflects the wages of Decker and Spring Creek miners who live in Sheridan County, grew fastest. Dividends, interest, rent, and transfer payments, which indicate the retired population's income, grew at the next fastest annual rate. Labor and proprietor's income grew slowest (table 2-13).

The increase in per capita income during the 1970s resulted largely from the increasing proportion of high-paying mine jobs, not from rising wages in other industries. Neither the real (adjusted for inflation) increases in mining wages nor the expansion of mining-sector employment significantly affected wages in the other industries. Rather, real wages in the other industries in Sheridan County closely followed State and national trends, although at a slightly lower level. The rapid increase in the supply of labor, due to in-migration and the increase in the labor-force participation rate, prevented real nonmine wages from being influenced by mine wages (Meale, Ingebrigtson, and Branch, 1983, p. 10). (See fig. 2-10.)

Recent layoffs at the Decker and Spring Creek Mines lowered per capita income nearly 11.1 percent from 1980 to 1984. Total personal income declined almost as much, falling 10.8 percent (MWR-N, 1985, p. 54).



SOURCE: MOUNTAIN WEST RESEARCH-NORTH, 1983

FIGURE 2-10 Rapid increases in mining wages in the Sheridan area have not affected wages in other sectors, which have closely followed State and national trends.

In the future, employment is expected to grow. If it is assumed that the Decker area mines eventually reach full employment and that no new mines are built, both total personal and per capita income are projected (through 2015) to grow. Total personal income is projected to increase from its 1985 low of about $216 million to a peak of $300 million in 2009. Per capita income (in current dollars) is projected to increase from its 1985 low of $13,000 to $14,201 in 2015 (MWR-N, 1985, p. 54).

TABLE 2-13

Components of Sheridan County Personal Income, 1970 and 1980

Components of Personal Income	Amount (Thousands of 1980 Dollars) 1970	1980	Percent of Total Personal Income 1970	1980	Average Annual Percentage Rate of Growth 1970 to 1980
Labor and proprietor's income	$92,216	$149,020	65.0	55.9	4.9
Less: personal contribution for social insurance	4,596	7,855	−3.2	−2.9	5.5
Plus: dividends, interest & rent	34,877	69,816	24.6	26.2	7.2
Plus: transfer payments	18,021	32,061	12.7	12.0	5.9
Plus: residency adjustment	1,422	23,321	1.0	8.8	32.3
Total personal income of county residents	$141,940	$266,363	100.1	100.1	6.5
Per capita income	$7,945	$10,611	na	na	2.9

Source: MWR-N, 1983, p. 3-225.

Higher prices can offset higher personal income. In Sheridan, mining wages have not pushed up wages in other sectors, so nonmine workers have not indirectly benefited from energy development. Conversely, employers have not indirectly suffered. People without jobs or those on fixed incomes are the most adversely affected by higher prices.

Firm conclusions cannot be drawn about the effect of energy development on consumer prices in Sheridan County. The limited data available do not support the conclusion that energy-related growth has resulted in substantially increased inflation in either wages or general commodity prices (Meale, 1983, p. 5). However, the price of some high-cost, fixed-site commodities, such as housing and subdivided land, has apparently been pushed up at faster-than-normal rates (Meale, 1983, pp. 4–5).

BIG HORN COUNTY

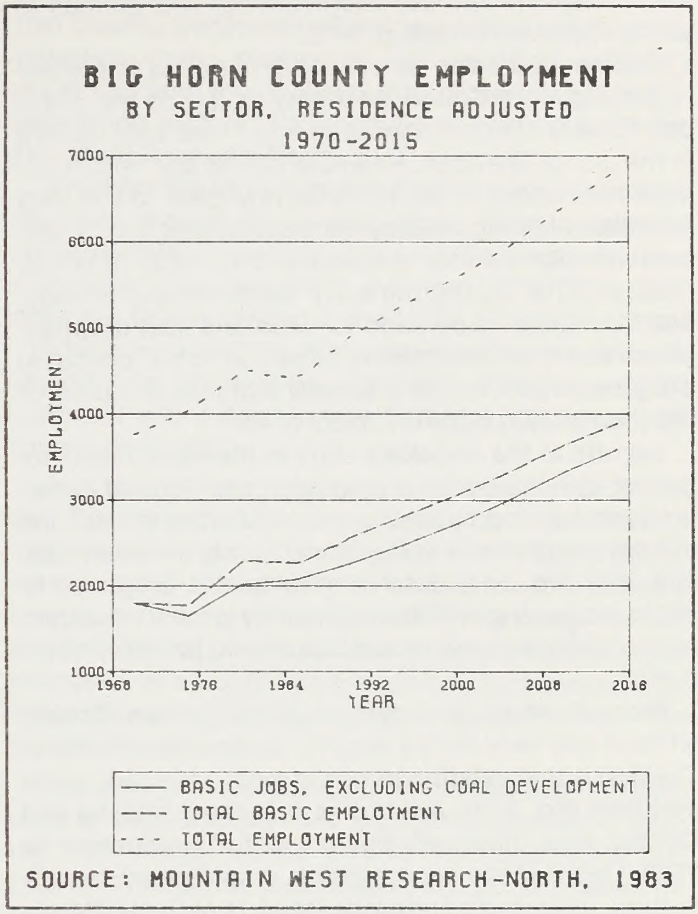
Industrial and Commercial Activity

Big Horn County grew and prospered during the last half of the nineteenth and first half of the twentieth century. Development focused on the basic agricultural economy that remains today. Compared to Sheridan County, Big Horn County grew less rapidly and, owing to a less diverse industrial base, underwent less economic fluctuation (Historical Research Associates, Inc., May 2, 1983, p. 107).

Livestock production, both sheep and cattle, dominates county agriculture. The Holly Sugar Company factory in Hardin, open until 1970, encouraged production of sugar beets (HRA, 1983, p. 107). Some grain, chiefly wheat and barley, is also grown in the county.

The two Indian reservations in Big Horn County, particularly the Crow Reservation, have helped shape the development of the county economy (MWR-N, 1983, p. 3-18; HRA, 1983, p. 108). Because of the reservations, Federal government money has flowed to county businesses via employment and transfer payments to tribal members. Meanwhile, ranchers have supported livestock operations by leasing grazing land on the Crow Reservation (MWR-N, 1983, pp. 3-18, 3-19). In some respects, Federal administration of much of the land in the county may have encouraged the establishment of large corporate agricultural operations, such as the Campbell Farming Corporation and the sheep operation of Charles Bair (HRA, 1983, p. 108).

Hardin is the principal trade center in Big Horn County. It is, however, a second-order center—it provides some specialized goods and services, but has a limited market area. Consumers from the northern part of the county tend to bypass Hardin to shop in Billings. Southern Big Horn County residents tend to make their major purchases in Sheridan, Wyoming (MWR-N, 1983, p. 2-64).



SOURCE: MOUNTAIN WEST RESEARCH-NORTH, 1983

FIGURE 2-11 After steady growth, employment in Big Horn County declined in 1980 as a result of the national recession and cutbacks in Federal Indian programs. Employment growth is expected to resume when coal production at the Absaloka Mine increases and other basic sectors recover.

Quantity and Distribution of Employment

As in the rest of the U.S., the number of rural agricultural jobs declined in Big Horn County between 1960 and 1980. Offsetting the decline was growth in mining, construction, and service employment. Between 1970 and 1980, total employment increased by about 18 percent (fig. 2-11), from 3,796 to 4,484 jobs (table 2-14). Agriculture, although declining, remained the largest basic-employment sector in 1980, and it is likely to stay the largest in the future, because almost all Decker-area miners live in Wyoming.

Basic-industry jobs in Big Horn County in 1980 stemmed from agriculture (41 percent), services (25 percent), government (18 percent), mining (11 percent) and other industries (5 percent) (MWR-N, 1983, p. 3-72). The high proportion of service and government employment demonstrates the importance of the Crow Indian Reservation to the county economy.

Nonbasic employment in 1980 was dominated by jobs in the trade and services industries, which made up 51 percent of the sector. Other major employers were government (22 percent), construction (7 percent), finance, insurance and real estate (5 percent), and transportation, communications, and utilities (5 percent) (MWR-N, 1983, p. 3-72).

Coal-related basic employment is not as important to the Big Horn County economy as it is to the Sheridan County economy because most coal workers live in the city of Sheridan. However, during the 1970s mining employment in Big Horn County grew to 292 jobs from zero. Mining employment accounted for 7.4 percent of total county employment in 1980 (MWR-N, 1983, p. 3-70). During the early 1980s, mining employment declined as demand for Montana coal dropped. Mine-related employment is projected to bottom out at 170 jobs in 1985 and to gradually increase to a peak of 366 jobs in 2002 (MWR-N, 1985, p. 48).

Layoffs at the Absaloka Mine in the early 1980s, together with the national recession and Federal Indian program funding cutbacks, contributed to the decline in total employment in Big Horn County between 1980 and 1982 (fig. 2-11). Total employment is projected to begin increasing in 1985 and steadily grow at moderate rates varying between 1 and 3.3 percent (MWR-N, 1985, p. 48).

Projections of employment for Big Horn County without any new mines require several assumptions. The first is that existing trends in most basic industries continue (fig. 2-11). Another is that the Absaloka and Decker area mines will operate at full production by 1990. Under these assumptions, employment in agriculture, following a statewide trend, is projected to undergo a slow long-term decline. Meanwhile, steady growth in the other basic industries, particularly government employment associated with the reservation, will gradually erode the dominance of agriculture as the predominant basic industry of Big Horn County.

Total employment is projected to grow from its low of 4,372 jobs in 1984 to 4,746 jobs in 1990, an increase of 8.6 percent (MWR-N, 1985, p. 47). In the 1990s and in the first decade of the twenty-first century, total employment is projected to increase by 16 percent, followed by a 14-percent increase between 2010 and 2015, reaching 6,711 jobs in 2015 (MWR-N, 1985, p. 47).

Community and Personal Income

Energy-related employment growth in Big Horn County between 1970 and 1980 markedly increased total and per capita personal income (MWR-N, 1983, p. 3-67). Total personal income (in constant dollars) increased by 60 percent and per capita income by 45 percent (MWR-N, 1983, p. 3-74). Labor and proprietor income, the fastest-growing contributor to total county personal income, more than doubled (MWR-N, 1983, p. 3-74), reflecting the relatively high salaries of mine workers. Much of this income, however, was earned by residents of Sheridan County and was spent in Wyoming. As a rsult, total personal and per capita income in Big Horn County went up by a smaller percentage than income from labor (MWR-N, 1983, p. 3-74).

Personal income also declined between 1981 and 1983. The 2.5-percent decline in employment between 1981 and 1983 produced about a 1-percent decline in total personal income. Because population continued to grow over the period, per capita income declined by about 2.2 percent (MWR-N, 1985, p. 60).

Growth in employment (assumed to occur without any new mines) will, after 1986, increase total personal income. From its 1983 low, total personal income will climb 8.5 percent by 1990. During the 1990s, it will grow by 16 percent, and between 2000 and 2015, by 22 percent (MWR-N, 1985, p. 47).

Population growth, as projected without any new mines, will partially offset income growth: Per capita income will not again reach its 1980 level until the latter half of the 1990s (MWR-N, 1985, p. 60). Per capita income will continue to grow steadily through 2015, and will be about 53.5 percent higher in 2015 than at the 1983 low point.

TABLE 2-14

Employment of Big Horn County Residents by Sector, 1980

	Total Employment		Basic Employment		Nonbasic Employment	
Industrial Sector	Amount	Percent	Amount	Percent	Amount	Percent
Agriculture	1,004	22.4	929	40.7	75	3.4
Mining	239	5.3	239	10.5	0	0
Construction	225	5.0	70	3.1	155	7.0
Manufacturing	49	1.1	0	0	49	2.2
Transportation, communications, and utilities	125	2.8	16	0.7	109	4.9
Trade	665	14.8	36	1.6	629	28.6
Finance, insurance, and real estate	131	2.9	13	0.6	118	5.4
Services	1,049	23.4	559	24.5	490	22.2
Government	996	22.2	418	18.3	578	26.2
TOTAL	4,483	99.9	2,280	100.0	2,203	99.9

Source: MWR-N, 1983, p. 3-72.

SOCIAL CONDITIONS

REGIONAL HISTORICAL OVERVIEW

Economically, socially, and politically, Big Horn County, Montana, and Sheridan County, Wyoming, have developed in much the same way. Both counties have been home to native American people, principally the Crow and later the Northern Cheyenne Indians. Exploration and settlement in the two counties included an active fur trade and, later, an open-range cattle industry. From 1850 to 1950, both counties grew and prospered, creating economies based on agriculture that permeated political and social institutions. (Note: This historical overview is a summary of a report by Historical Research Associates, 1983.)

Despite broad similarities, the historical development of the two counties has differed in some respects. Sheridan County, for instance, has grown faster with greater population fluctuation than Big Horn County. This growth and fluctuation has stemmed from the greater variety in the Sheridan economy. Coal mining and agriculture together formed the industrial foundation of the county by the early twentieth century. Broadening the economic base was recreation, represented by dude ranches. Further diversity was added by retired Montana and Wyoming residents in the community. Medical and social institutions supporting the elderly helped to characterize Sheridan as a retirement community.

In contrast, Big Horn County development focused on one industry—agriculture. Sheep and cattle production dominated, accompanied until 1970 by sugar beet production for the Holly Sugar Company factory in Hardin. Hardin, serving as a local trade center for the county, broadened the economic base, but many county residents traded in Billings or Sheridan instead.

Additional factors also set apart the development of Big Horn and Sheridan counties. For example, the two Indian reservations in Big Horn County have given control of almost two-thirds of the land in the county to the Federal government. Moreover, Big Horn County was not organized until 1913, and therefore lacked coordination of land use until after that time.

REGIONAL SOCIAL ORGANIZATION

Being agriculturally based, both Sheridan and Big Horn counties will continue to experience a changing political and social environment from industrial expansion, principally coal development. The change will be especially evident in Big Horn County, where little industrial growth has occurred in the twentieth century and where a strong identity with an agriculturally oriented economic, political, and social structure has been retained. Exchange will be less evident in Sheridan County, particularly Sheridan, where much of the county's early prosperity and political maturity stemmed from the coal industry. (Note: The social organization section is a summary of a report by Mountain West Research-North .)

Sheridan County's history of cultural and economic diversity shaped social conditions. Such conditions were modified by a prolonged period of economic and population decline lasting into the 1970s. The economy was briefly revived in the 1970s by expanded coal strip-mining activities. Although significant and rapid, the recovery was smaller and shorter than generally anticipated and a downturn in mining employment followed after 1980.

As a result of past and recent developments, Sheridan County's social, economic, and political diversity is greater now than at any time since the 1920s. The recent surge in nonagricultural employment reversed a long-term trend: increasing dependence on agriculture and the Federal government as an economic base. The economy, as a result, has attracted newcomers with diverse personal backgrounds, especially into the greater Sheridan area.

The growth in the energy industry has given experience to both Sheridan and Big Horn Counties in dealing with energy-related growth. The experience has prepared residents, businesses, and governmental organizations to deal more effectively and pragmatically with future growth. Communities have established alliances and contacts with State and Federal agencies and with other local governments that can provide information, money, and expertise. The experience with energy development has reduced regional isolation and, in turn, integrated local concerns into regional, State, and national affairs. To some local people, this change has been viewed as advantageous, to others, as an intrusion of the outside world into local and personal relationships.

As the economy and population have changed, the opportunities for political, economic, and social power (influence and status) have been adjusted. As newcomers with professions or allegiance to outside organizations have become more numerous and important, and as the proportion of the population in the working ages has increased, the dominance of the elderly and of ranchers with "pioneer" heritage has been reduced.

One of the challenges placed on communities by the energy-related growth of the 1970s was to improve organization and coordination. Because most mining was in Montana while most population growth occurred in the greater Sheridan area, the problems of coordination and cooperation became more important. Local officials in Sheridan County were pressed into developing a strategy for controlling and responding to growth. In the process, they updated or reevaluated governmental procedures and policies. They instituted more aggressive funding and taxing programs, planning, and land use practices. And they initiated a more active dialogue between the communities and the county. Both the county and the communities in the Sheridan area were successful in obtaining State and Federal assistance during the period of rapid growth.

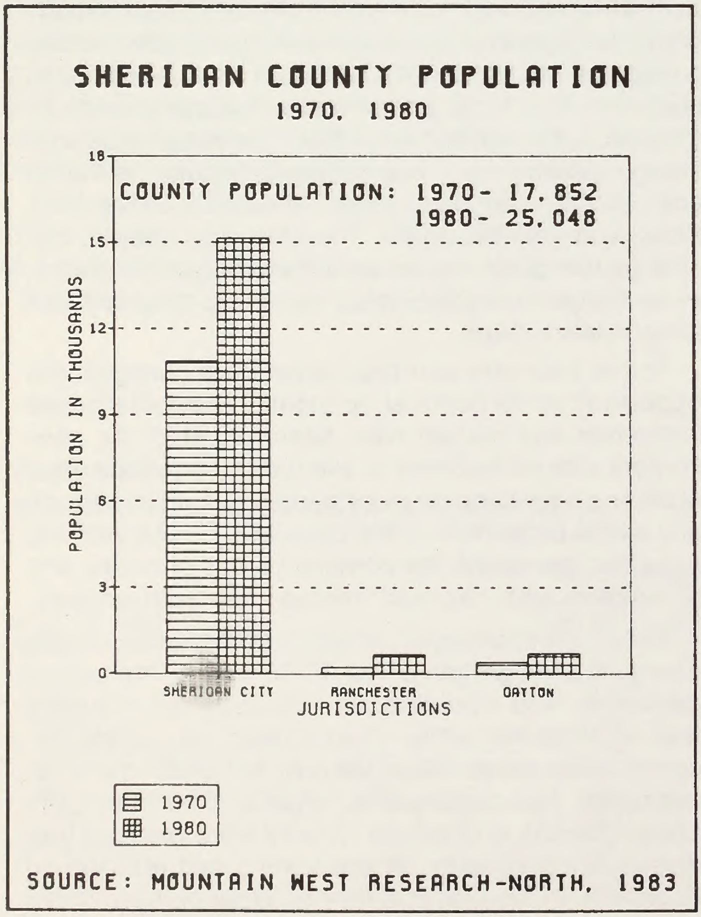
SHERIDAN COUNTY

Population

The population of Sheridan County was 25,048 in 1980, a 40.3-percent increase over 1970. (See fig. 2-12 and app. B, table B-10.) This population increase was only slightly less than the Wyoming statewide increase of 41.6-percent, and was slightly more than the 39.5-percent population increase in the city of Sheridan over the same ten years. Ranchester grew a very rapid 214.9 percent and Dayton grew 77 percent over the decade.

The median age in Sheridan County decreased from 36.8 in 1970 to 29.8 in 1980. The ethnic distribution remained relatively stable: The percentage of white residents decreased from 98.9 percent in 1970 to 98.4 percent in 1980. The ratio of males to females also remained stable over the decade: Males increased from 49.5 percent of the population in 1970 to 49.8 percent in 1980 (MWR-N, 1983, pp. 3-207 through 3-216).

FIGURE 2-12 During the 1970s, the population of Sheridan County grew at about the same rate as the State of Wyoming as a whole, about 40 percent. Of the three county areas shown, Ranchester grew at the fastest rate, 215 percent, and Sheridan City at the slowest rate, 39.5 percent.



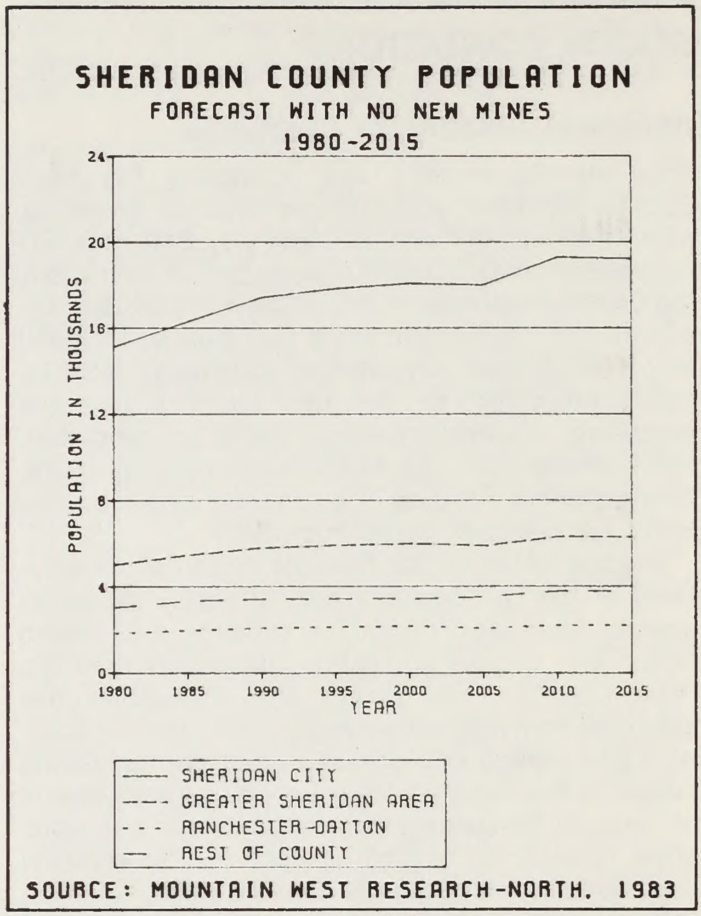


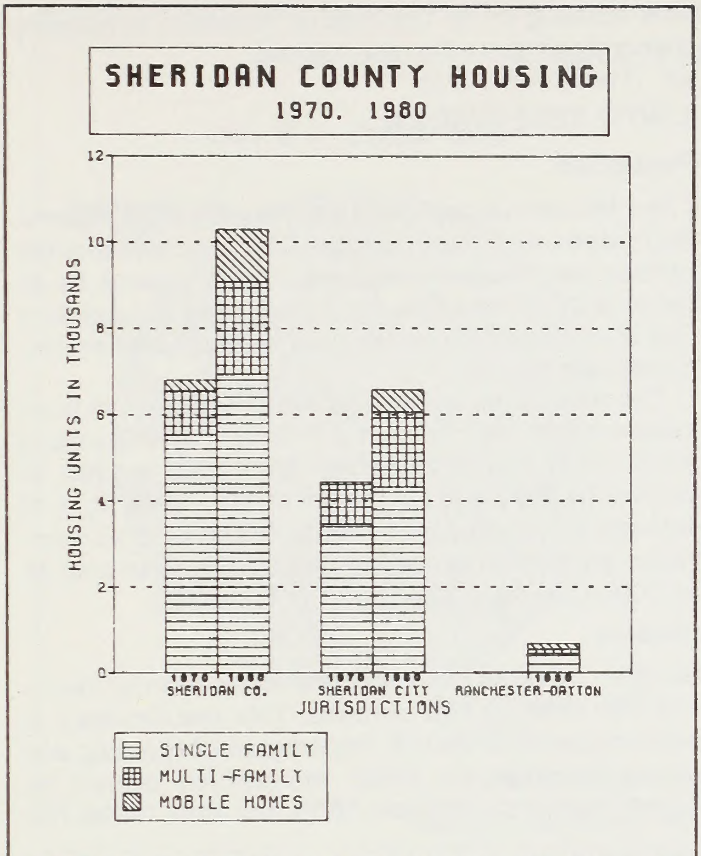
FIGURE 2-13 The population of Sheridan County will grow much slower in the years ahead than in the past if no new mines are built. By 2015, the current population of 26,469 will be only about 25 percent larger, reaching 31,507. (Note that the graph line for the greater Sheridan area excludes Sheridan City.)

With no new mining nearby, the county population is projected to increase at a moderate rate. (See fig. 2-13 and app. B, table B-11.) From 1980, the population is projected to increase 2.5 percent by 1990, 17.2 percent by 2000, and 22.2 percent by 2015. The percentage increase in population for the different areas within the county is about the same.

Housing

During the 1970s the county year-round housing supply increased a rapid 51.4 percent. (See fig. 2-14 and app. B, table B-12.) The rate of increase within the city of Sheridan was similar (48.3 percent). In the Sheridan-Ranchester area, where 1970 information was not available, the rate was probably higher.

The forecasted increase in housing demand (app. B, table B-13) without any new mines resembles the population increase—moderate rises spread evenly over the county. Local developers are capable of meeting the demand.



SOURCE: MOUNTAIN WEST RESEARCH-NORTH, 1983

FIGURE 2-14 The Sheridan County housing supply grew by over 50 percent during the 1970s, rising from a total of 6,799 units in 1970 to 10,295 in 1980. Note that housing data for the Ranchester-Dayton areas were unavailable in 1970.

BIG HORN COUNTY

Population

Big Horn County is divided into three nonreservation subcounty areas: Big Horn County North, Hardin City, and Decker. Big Horn County North includes all of the county north of the reservations, except Hardin City. The Decker area includes all of southeastern Big Horn County outside the reservations.

Overall, the county population increased 10.3 percent from 1970 to 1980, 3 percent slower than Montana as a whole. (See fig. 2-15 and app. B, table B-1.) The three nonreservation units within the county underwent sharply different population changes. The population of the northern part of the county increased by a rapid 762.7 percent, the Decker area decreased by 22.9 percent, and the city of Hardin increased by 20.7 percent.

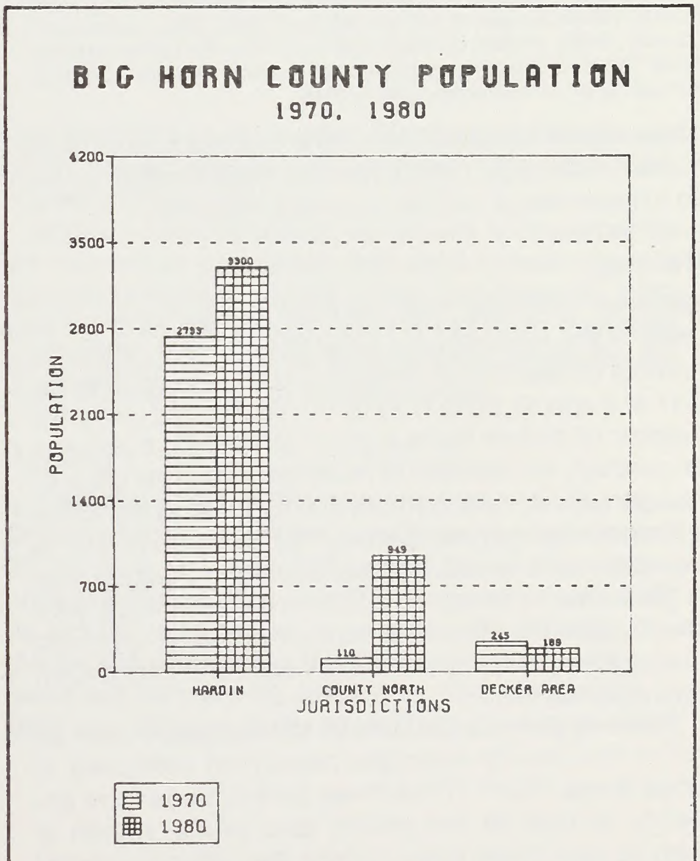
The median age increased in Big Horn County by over two years between 1970 and 1980. (See app. B, table B-2.) Even so, in both 1970 and 1980 the median age was over three years less in Big Horn County than in Montana as a whole.

The percentage of nonwhite (mostly Crow and Northern Cheyenne Indian) population is much higher in Big Horn County than in the entire State. (See app. B, table B-2.) Census figures show that the percentage of nonwhites increased from 40.2 in 1970 to 47.9 in 1980. The Crow Reservation analysis assumed that the 1980 census undercounted Crow Indians living in Big Horn County by about 21 percent. If this is correct, Crow and Cheyenne Indians actually constitute over 50 percent of the county population, and the median age in the county is probably lower.

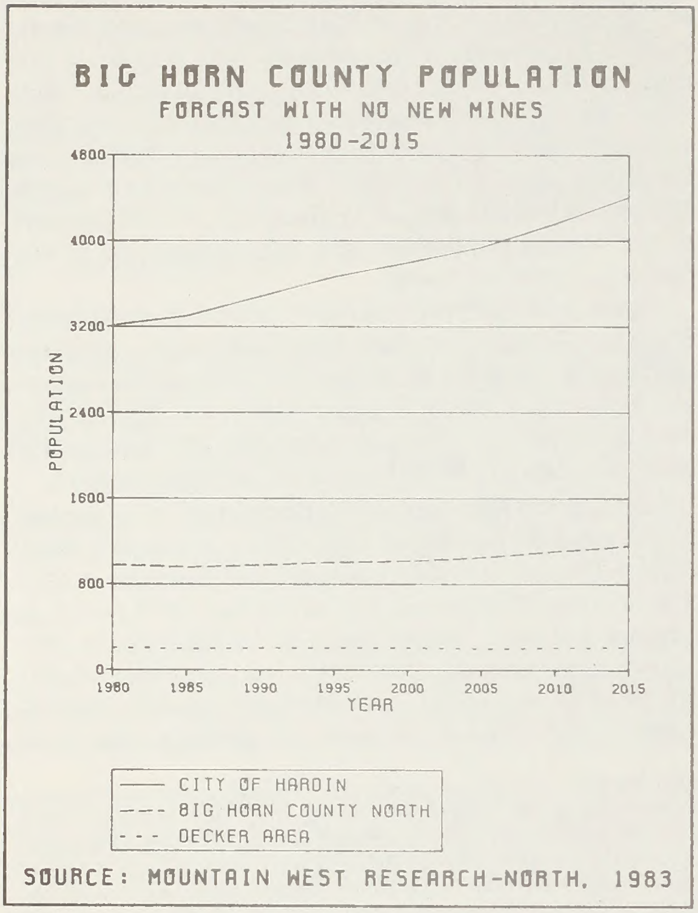
Figure 2-16 summarizes the expected population in Big Horn County if no new mines are developed. (See also app. B, table B-3.) The expected increase is moderate. Projections show the population increasing over the 1980 level by 11.5 percent by 1990, 25.1 percent by 2000, 38.4 percent by 2010, and 47.7 percent by 2015.

None of the nonreservation population is projected to increase as rapidly as the county population as a whole. The population of Hardin will increase faster than the other two areas, but by the year 2015 the 37.1-percent increase would be 10.6 percent below the countywide increase. Over the same period, the northern area of the county is expected to increase only 28.5 percent and the Decker area 5.9 percent. The data

FIGURE 2-15 In percent, population changes varied widely in different parts of Big Horn County during the 1970s. In the northern part, the population grew 762 percent; in the Decker area, the population fell 23 percent. Overall, the Big Horn County population grew much more slowly, at 10 percent, than did Sheridan County between 1970 and 1980, climbing from 10,057 to 11,096.



SOURCE: MOUNTAIN WEST RESEARCH-NORTH, 1983



SOURCE: MOUNTAIN WEST RESEARCH-NORTH, 1983

FIGURE 2-16 Without the addition of any new mines, Big Horn County will grow from 12,746 in 1985 to 17,986 in 2015, a rise of 41 percent. Much of this increase will occur on the Indian reservations. The most rapidly growing nonreservation area will be Hardin, increasing 37 percent from 1985 to 2015.

show that the population on the reservations is likely to increase faster than in nonreservation areas, owing to a faster rate of natural population growth.

Housing

Between 1970 and 1980 the total number of housing units in Big Horn County grew 33.3 percent, while the number of year-round units grew 29.8 percent. (See fig. 2-17 and app. B, table B-4.) Of the year-round units, the number of mobile homes grew fastest, 174.6 percent. In contrast, the number of multifamily homes grew by 71.1 percent, and the number of single-family detached units grew by only 14.8 percent. By 1990, the county is expected to need nearly 17 percent more housing than in 1980, even without the addition of new mines. (See app. B, table B-5.) The total additional need is expected to increase to over 36 percent by 2000 and over 64 percent in 2015.

Housing demand patterns in the nonreservation areas in the county resemble population increases in those areas. None of the three jurisdictions have demands as high as the county as a whole. Hardin is likely to need more housing than the other two areas; the Decker area is likely to need the fewest number of new housing units. The bulk of increases in housing demand will be on the reservations.

CROW RESERVATION

Population

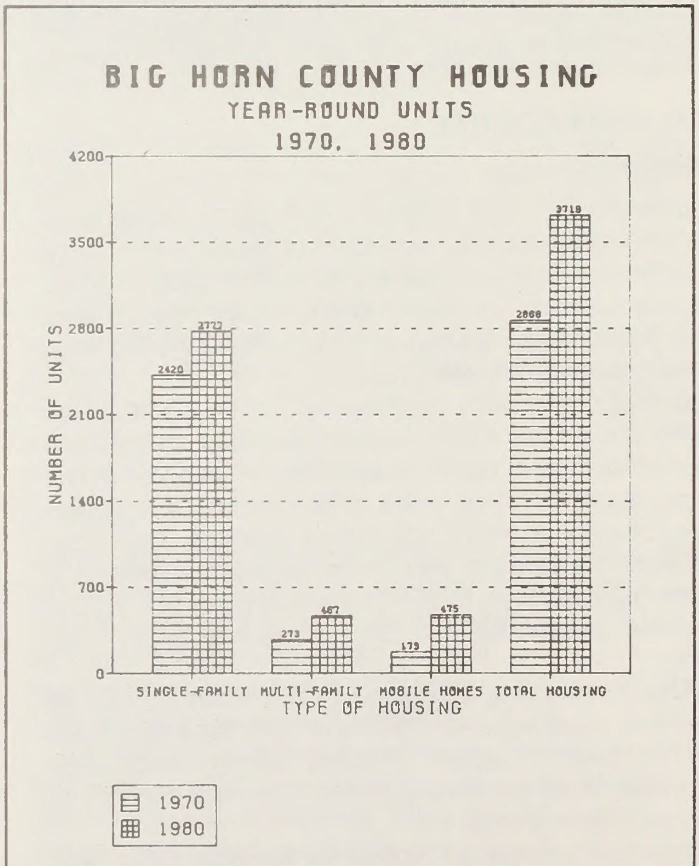
The 1980 census counted 5,645 people on the reservation. Information from the Crow Tribe indicates that the census may have undercounted Crow Indians by as much as 21 percent. (See fig. 2-18 and app. B, table B-6.) The actual population may thus be much higher than the census shows.

The reservation Indian population is expected to increase rapidly even without any new mines. The total is projected to rise by 22 percent from 1980 to 1990, 38 percent by 2000, and 69 percent by 2015. (See fig. 2-19 and app. B, table B-7.) In contrast, the non-Indian reservation population is not expected to increase until after 2000. (See fig. 2-19 and app. B, table B-8.)

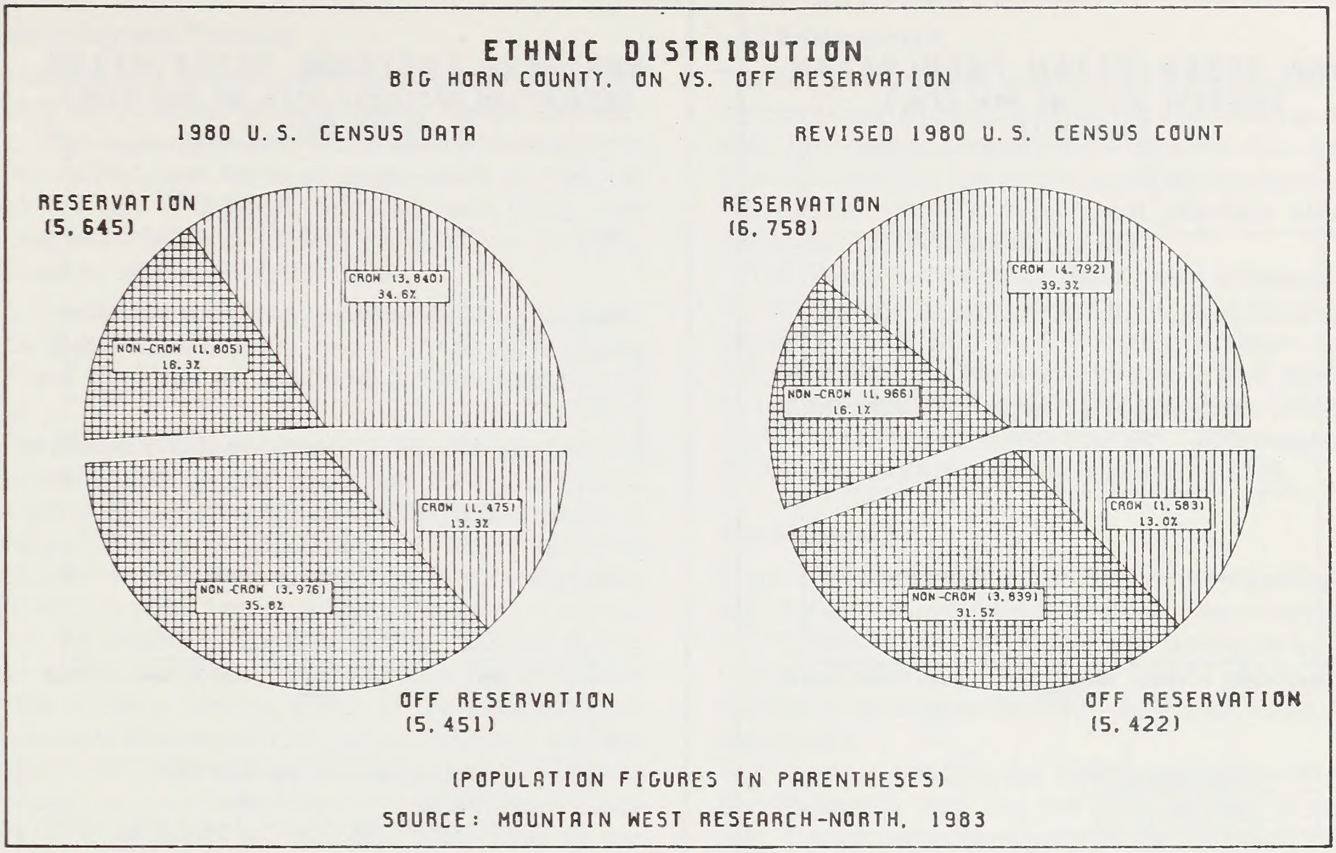
Housing

Housing for Crow Indians on the reservation is insufficient to meet current demand. This insufficiency is partly because of the U.S. Department of Housing and Urban Development (HUD) moratorium placed on house financing in the late 1970s and early 1980s. The

FIGURE 2-17 The amount of housing in Big Horn County grew by 30 percent during the 1970s, much faster than population growth. The number of mobile homes grew at the fastest rate, 175 percent.



SOURCE: MOUNTAIN WEST RESEARCH-NORTH, 1983



(POPULATION FIGURES IN PARENTHESES)

SOURCE: MOUNTAIN WEST RESEARCH-NORTH, 1983

FIGURE 2-18 U.S. Census data *(left)* indicate that the Crow Reservation population makes up about half of Big Horn County. Data revised for a possible undercount of the Crow Tribe *(right)*, suggest that the reservation may make up closer to 56 percent of the county.

moratorium has now been lifted, and 115 new units are scheduled for construction (MWR-N, 1983, p. 3-155).

Increases in housing demand follow the same pattern as population increases. Local developers are expected to be able to supply that demand through the year 2015. (See app. B, table B-9.) Projected demand is slightly above the capacity of existing firms for three years. Local builders, however, will expand their capability, or nonlocal builders will provide the capability to supply all housing needed.

NORTHERN CHEYENNE RESERVATION

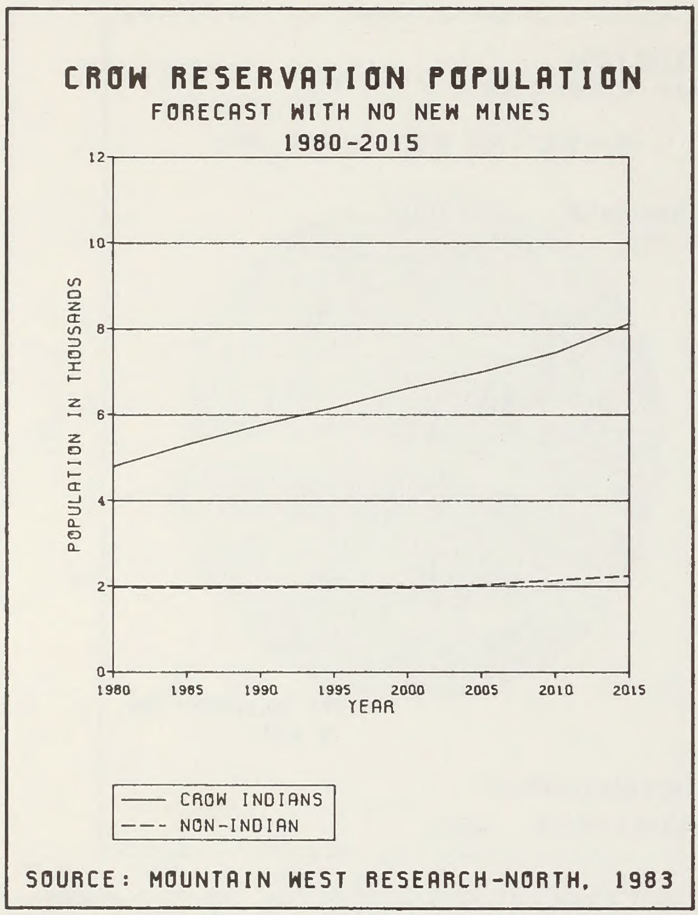
Population

The 1980 population on the Northern Cheyenne Indian Reservation was 3,255. In the Big Horn County portion there were 822 people, about 25 percent of the reservation total. The Northern Cheyenne population has a younger median age than the surrounding non-Indian population: About 50 percent of the population is sixteen years of age or younger. (For more detailed population characteristics see Northern Cheyenne Tribe Planning Office, 1981.)

Without any new mines, no growth is projected for the non-Indian population, but rapid growth (over 62 percent) is forecast for the Indian population by 2010. (See fig. 2-20 and app. B, table B-14.) Such increases are projected for both the total reservation and the Big Horn County portion of the reservation.

Housing

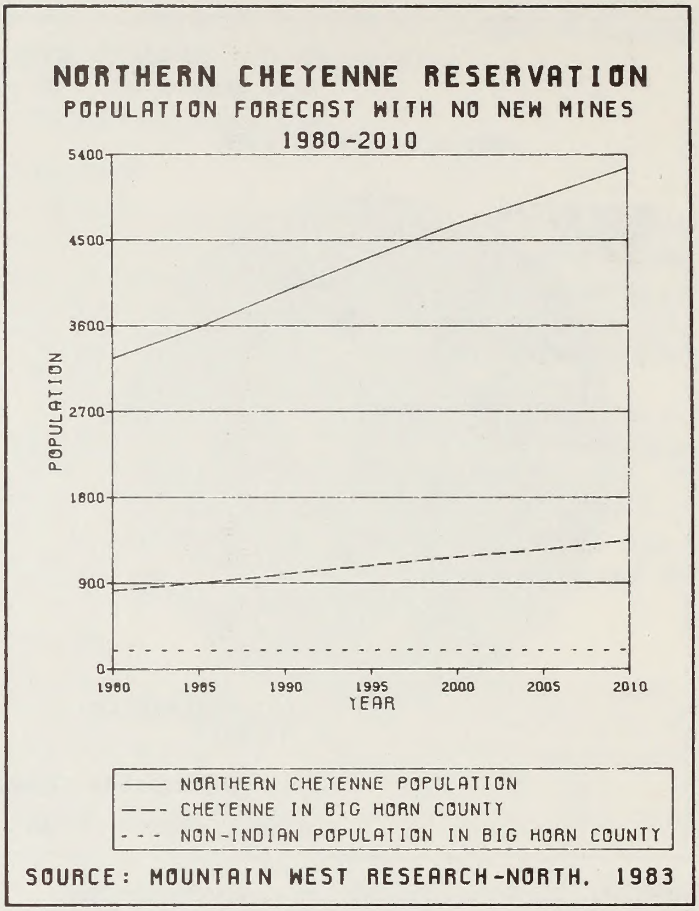
In 1980 there were 288 housing units on the Big Horn County portion of the Northern Cheyenne Reservation. Of the total, 217 were Indian and 71 were non-Indian units (MWR-N, 1983, p. 3-205). The demand for housing by Indians is expected to increase dramatically over the next 30 years: From the 1980 stock of 217 units, demand will increase 30 percent by 1990, 68 percent by 2000, and 106 percent by 2010 (MWR-N, 1983, p. 4-167).



CROW RESERVATION POPULATION
FORECAST WITH NO NEW MINES
1980-2015

SOURCE: MOUNTAIN WEST RESEARCH-NORTH, 1983

FIGURE 2·19 By natural population increase alone, the Indian population will grow by nearly 70 percent over the next 30 years, from about 5,500 in 1985 to 8,167 in 2015. The non-Indian population will grow slowly, rising only 15 percent, from about 2,000 in 1985 to 2,245 in 2015.



NORTHERN CHEYENNE RESERVATION
POPULATION FORECAST WITH NO NEW MINES
1980-2010

SOURCE: MOUNTAIN WEST RESEARCH-NORTH, 1983

FIGURE 2·20 Like the Crow population, the Northern Cheyenne population is expected to increase rapidly even if no new mines are built. In the Big Horn County part of the reservation, shown by the graph, the population is forecasted to grow from 822 in 1980 to 1,358 in 2010, a rise of 65 percent. The non-Indian population is not expected to grow during this period.

SOCIAL AND COMMUNITY SERVICES

SHERIDAN COUNTY

The county provides the following services:

- general government
- engineering and planning
- law enforcement
- fire protection
- hospital
- library
- recreation and parks
- education

Most services are administered from the city of Sheridan. Some of the county services and some additional services are provided by other cities in the county. A description of county services and those provided by the cities of Sheridan, Ranchester, and Dayton follows. (For greater detail, see Mountain West Research-North , 1983, pp. 3-232 through 3-258 and 4-179 through 4-187; and MWR-N, 1985.)

General Government

The steady but modest population growth projected for Sheridan County through 2015 will demand little increase in general government services. The new county courthouse, completed in 1982, coupled with the old county courthouse, recently renovated and refurbished, is expected to adequately serve the population. There is a comfortable surplus of administrative space at this time (MWR-N, 1985, p. 15).

In Sheridan, on the other hand, the 14,775-square-foot city hall, constructed in 1910, has no room for expansion. Even with no new mines, it is projected that more administrative space will be needed in 1985, in 1994, and in 2002. Some remodeling of the facility will begin in 1985.

Ranchester has adequate administrative space for the growth projected with no new mines, but Dayton may need slightly more space by 2015.

Engineering and Planning

The county has responsibility for roads, bridges, permitting septic tanks for single-family homes, and planning. The major deficiency today is that most bridges in the county need repair or replacement. Estimating costs for this is difficult, because each bridge has unique features. A prioritized replacement program, initiated in 1982, is being pursued.

An additional deficiency is shop space. Standards show that the county now needs 27,423 more square feet and will need an additional 2,800 square feet by 2002.

The Sheridan City engineering department oversees engineering, planning, utilities, sanitation, and streets. The sewer system, expanded in 1983, has capacity to serve a population of 29,000 persons. The system's capacity will exceed the needs of the projected population through 2015. The capacity of the water system is about 10,000,000 gallons, which is reached during peak summer months. Improvements are necessary for the existing system. Some of the necessary improvements include spillway rehabilitation of the Twin Lakes Reservoir, construction/replacement of existing raw-water transmission lines, and additional treated-water storage (MWR-N, 1985, pp. 19–20). The city has recently obtained additional water rights adequate to serve a population of 29,000.

The streets in the city of Sheridan are generally in good condition. The city has requested $6.12 million in coal tax funds to fund street maintenance. Storm drainage is inadequate; funding has been budgeted for a drainage study to develop solutions to the multijurisdictional drainage problem. The existing 40-acre cemetery was recently expanded by over 35 acres and is considered by local officials to be adequate for many years to come.

The city's 9,600-square-foot shop was expanded in 1983 by 3,600 square feet, bringing the total to 13,200 square feet. Standards indicate a need for 17,000 more square feet of shop space by 2015. The city is planning additional expansion to the shop, but no definitive plans have been made (MWR-N, 1985, p. 18).

The city's solid waste system is being expanded and updated. An additional 125 acres for landfill were recently purchased. Equipment is mostly new and in good condition, and the collection system is being automated. There are no problems with expanding services to accommodate projected population growth.

The Ranchester sewer system has undergone recent improvements and now has adequate capacity to serve a population of 2,000. The Dayton water system has the capacity to serve 1,700 people. The community is discussing adding storage capacity. Small additions are also needed for roads and sewage collection and treatment systems.

Law Enforcement

The combined county and city law enforcement facility, completed in 1982, is expected to conveniently absorb the increase expected in demand. The city of Sheridan provides law enforcement service for the city; the county sheriff's department provides services mainly to citizens outside the city.

The Sheridan City police department is housed with the county sheriff department in the new facility constructed in 1982. Both the administrative space and the number of jail cells are considered more than adequate to handle expected growth through 2015. Using the current ratio of two policemen per 1,000 population, about 8 more officers will be required by 2015.

Fire Protection

There are no plans to expand county fire services for any of the five rural fire districts or for the county facility. Projections based on planning standards indicate that an additional 2,000 square feet of space will be needed at the county facility by 2001 even without any new mines.

A recently constructed 10,000-square-foot fire station increased total city fire space to 14,284 square feet. The city remains slightly below the national planning standard, but the city owns a site for another fire station in case expansion becomes desirable. The county also has a fire district located at the nearby airport, although no mutual-aid agreement exists. The national planning standards indicate about 6,000 more square feet of fire protection space will be needed in 2015. The fire department is now manned by 18 full-time personnel and 10 reservists (MWR-N, 1985, p. 21).

Hospital

The Sheridan County Memorial Hospital has 89 beds. The current occupancy rate is 51 percent. Population projections without new mines indicate that four more hospital beds will be needed by 2002.

Human and Health Services

Sheridan County's Division of Public Assistance and Social Services (D-PASS), part of the Montana Department of Health and Social Services, serves all Sheridan County. D-PASS services are broad ranging. Public-assistance programs include, among others, food stamps, financial help, aid to families with dependent children, low-income energy assistance, and eligibility determination for medicaid. Social-service programs include adoption, family planning, investigative services for child protection, and homemaker services for the elderly and disabled.

D-PASS moved in 1983 to a new location with 3,400 square feet. The new offices have less space, but are more functional. The staff today totals 14: a director, three clerical personnel, one fiscal-control technician, four public-assistance personnel, and five social-service personnel. One of the public-assistance personnel is a temporary employee authorized by the legislature through the end of fiscal year 1986. The director indicates that one more public-assistance staff member and one additional clerical staff member are needed (Mary Blaine, Director of Sheridan County D-PASS, pers. com., February 27, 1985).

The current D-PASS case load is about 800 open cases per month, including 590 public-assistance and 203 social service cases. According to the director, the load has been increasing steadily at 10 percent per year. In 1982, however, the public-assistance case load increased more than 10 percent, due to high unemployment. The administrative requirements have also increased, causing an added workload.

Library

Construction is planned for mid-1985 to add 10,000 square feet of library space to the existing 13,700-square-foot main library in Sheridan. Branch libraries are located in Ranchester, Story, and Clearmont. The library service, personnel, and materials will expand with the planned facility. The system adequately serves today's population and with the planned expansion will easily accommodate growth projected with no new mines.

Parks and Recreation

The county does not operate a park and recreation department; it does support the county fairgrounds. The fairgrounds need expansion and relocation, and projected growth will exacerbate today's crowded condition.

The city of Sheridan has about 124 acres of park land, excluding the golf course. The park land adequately serves the population. The recreation department lacks indoor facilities, but does use some school facilities. A YMCA with excellent programs and indoor facilities is also located in town.

Complete development of the 124 acres of park land and estimated 100 acres of golf course land would put Sheridan over National Recreation and Park Association standards. The 224 acres are considered adequate through 2015 for the population projected with no new mines. Sheridan also is considering building an indoor recreation complex. The national standard for indoor recreation facilities is one per 125,000 people.

Both Ranchester and Dayton are projected to need slightly more park space to adequately serve population growth with no new mines.

Education

Sheridan County has three school districts. Only districts 1 and 2 would be affected by future mining. School district 1 covers the western portion of Sheridan County. Most facilities are in Ranchester and Dayton. Based on student space standards, current total space capacities are projected to be adequate through 2015 for elementary, middle, and high schools. In contrast, the number of teachers needed is projected to increase to 100 in mid to late 1995 from 92 today and then decline to 72 in 2004. Similarly, the need for support personnel is forecast to increase to 53 from 49 today and then decline to 39 in 2004.

By the fall of 1985 school district 2, serving the Sheridan City area, will open newly constructed elementary and high schools (MWR-N, 1985, p. 31). The total capacity of all elementary schools in district 2 is 2,900 students. The high school has a 1,200-student capacity, which can be expanded to 1,500 students. The middle school capacity is 1,400 students (MWR-N, 1985, p. 30). No new schools will be needed through 2015, assuming no new mines are opened.

By 1995, the demand for teachers in district 2 is projected to reach 371, an increase of 52 over the 1982 level, and then decrease to under 320 by 2007. The projected trend for support personnel is similar, reaching a total demand of 195 in 1995 and falling to under 170 by 2006.

BIG HORN COUNTY

The county provides the following services:

- general government
- engineering and planning
- law enforcement
- fire protection
- hospital
- library
- human and health services
- parks and recreation
- solid waste
- education

Most of these services are administered from Hardin, but equipment and personnel are in various locations. Some of these and additional services (water and sewage) are also provided by the city of Hardin. A detailed description of each service is contained in a 1983 report by Mountain West Research-North, Inc. (MWR-N, 1983, pp. 3-82 through 3-107 and 4-59 through 4-72).

General Government

Staff and facilities are now adequate for both Hardin City government and Big Horn County government. With no new mines, the county, according to population forecasts through 2015, will not need more office space. The city of Hardin, however, is likely to need both more space and one more employee by 2015.

Engineering and Planning

County space, staff, vehicles, and equipment are sufficient for current needs. County shop space is insufficient. A 10,800-square-foot addition to the shop is planned that will be adequate for existing needs, but will require expansion by 2015. A county shop containing 6,900 square feet has been constructed recently in the Decker area.

Hardin's engineering and public works department now has sufficient personnel and space. Projections indicate that even with no new mines two more people and additional space will be needed by 2015.

Law Enforcement

The sheriff's department provides law enforcement for the county and city of Hardin. The number of staff (18 to 20) and vehicles (9) has not changed for the past few years and appears adequate. A recent addition to the courthouse makes the facility adequate for both current needs and future growth, although the jail does not satisfy the new juvenile-prisoner standards.

Fire Protection

The Big Horn County fire department, staffed entirely by volunteers, serves the unincorporated parts of the county. The county plans to hire a new fire marshall, whose job will be to reorganize county fire services. If new residents settle in existing residential patterns, no additional buildings or equipment will be required through 2015.

Hardin's fire protection is provided by a 20-member volunteer department. Projected growth without new mines will not require a paid staff or additional equipment.

Hospital

The Big Horn County Hospital is a self-supporting nonprofit government agency. Fees and charges cover operating and maintenance costs; the county purchases capital equipment. The hospital has 16 acute and 34 long-term care beds. The acute care beds now average 56-percent occupancy, and long-term beds nearly 100-percent occupancy. By either local or national standards, little expansion will be needed to serve peak demand.

The hospital also provides nursing-home beds. In 1983 a new 36-bed nursing home and 20-unit retirement home were constructed and should provide adequate hospital services for anticipated population growth.

Library

The Big Horn County library in Hardin serves the entire county. Facilities are considered adequate, although the librarian feels expansion could be necessary if the population increases significantly (MWR-N, 1983, p. 3-87). Due to projected growth, even without new mines, the library may need to expand or seek other alternatives such as bookmobiles contracted with the Montana State Library system.

Human and Health Services

Ambulance and public-health services are provided for the entire county from Hardin. The ambulance service adequately serves current needs. Growth even without new mines may require additional personnel or equipment, but this will not be a county responsibility, since the ambulance service is privately owned. The number of public-health personnel has remained constant in recent years. Because a large variety of services is offered, the amount of expansion that will be needed to serve projected population growth is unknown. The Big Horn County Public Welfare Department now has two employees, using 2,040 square feet of space. By 2015, the department is projected to need three more employees and about 800 more square feet of space.

Parks and Recreation

Big Horn County oversees the county fair board and the county park board. The fairgrounds have recently been expanded for social events. The county park board has coordinated construction at the fairgrounds of softball fields, which were built using county funds and volunteer labor. The resulting increase in recreation facilities will adequately serve population growth.

Hardin now contains 5 acres of developed and 2.25 acres of undeveloped park land. Two to three additional acres will be needed even if no new mines are built. The town already owns the additional acreage.

Solid Waste

Big Horn County takes part in a tricounty solid waste system established in 1978. Collection is supplied by private contractors, who will be able to expand their operations along with increases in population. The landfill site, owned by Hardin but operated by the county, covers about 40 acres. It is adequate for another 20 to 25 years.

Hardin is responsible for garbage collection in town, using two trucks, each with a crew of three. Even without the development of new mines, one additional employee will be needed by 2015.

Water

Hardin's water system has been gradually renovated over the past 20 years. The treatment facility has a capacity of 4 million gallons per day and is adequate for a population of 27,000. Water storage capacity is sufficient for a population of 6,500. Neither treatment nor storage capacity will be exceeded by population growth.

Sewage

Hardin's sewer system is new and consists of oxidation ditches and an activated sludge plant. Local sources indicate that the system's 1-million-gallon capacity is adequate for a population of 6,000. No expansion of the system will be required by projected population growth.

Education

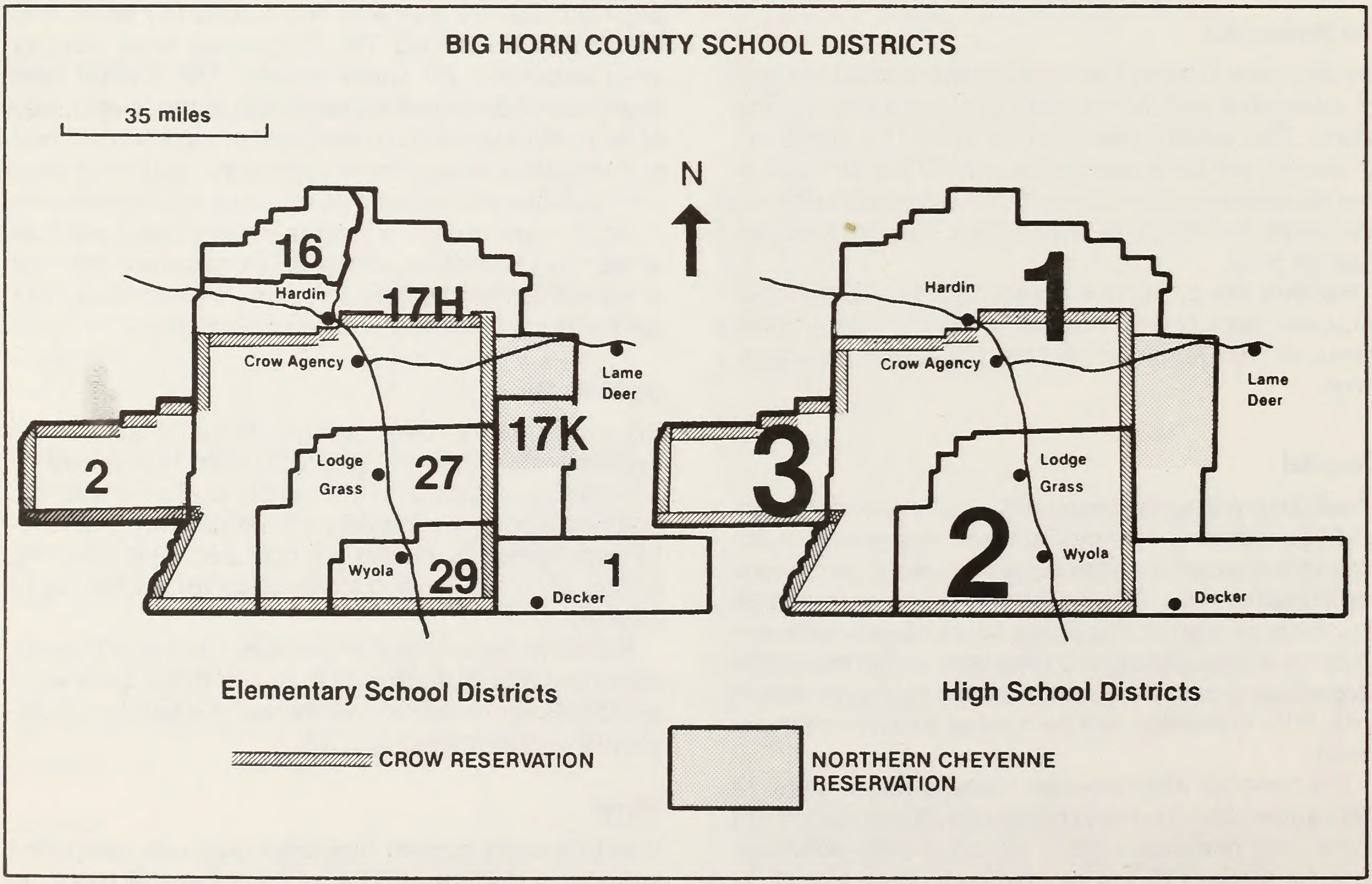
Big Horn County is divided into three high school districts and seven elementary school districts (fig. 2-21). Even without the development of new mines, the three high schools and ten elementary schools in the public school districts of Big Horn County are projected to need more personnel in both the mid-term (1995) and long term (2015). Space for each of the high schools, in contrast, is expected to be adequate. Eight of the elementary schools also have adequate capital facilities for projected needs. The elementary schools in Lodge Grass, however, would require more capital facilities prior to 1987.

Total elementary school and high school enrollment without new mines is expected to increase at a near constant rate through 2015. Total student enrollment is projected to increase from 2,399 in 1984 to 2,780 in 2015. The majority of the increase (208 students) will occur by 2000 (mid-term), and the remainder (173 students) after 2000.

Like enrollment, the need for personnel and teachers is forecast to increase at a relatively constant rate through 2015. Total demand for teachers is expected to increase 21.6 percent, from 189 full-time teachers today to 241 in 2015. Eighteen more staff will be needed by 1995 and an additional 22 will be needed between 1995 and 2015.

In the same way that elementary school students predominate enrollment, elementary school teachers would be the major component of total teachers: 72 percent in the mid-term and 73 percent in the long term. Demand for elementary school teachers will increase 25 percent, from 132 today to 175 in 2015. Twenty-one (15.9 percent) more teachers will be needed by 1995 and an additional 17 (12.8 percent) be-

FIGURE 2-21 Even without the addition of new mines, the school system in Big Horn County is expected to demand more space and personnel. The future needs of each school vary widely.



tween 1995 and 2015. Meanwhile, demand for high school teachers will increase 13.6 percent, from 57 full-time equivalent teachers today to 66 in 2015. In the mid-term, however, the demand for high school teachers is expected to increase from 57 today to 61 in 1995.

The demand for more capital facilities at the elementary school in Lodge Grass is expected to increase nearly constantly through 2015. The total expected increase is 32 percent, 17 percent occurring by 1995 and 15 percent after 1995.

CROW RESERVATION

In many cases, the finance, administration, and operation of public facilities and services on the Crow Indian Reservation involve many government units. The Crow Indian Tribal Government (CITG), Bureau of Indian Affairs (BIA), Indian Health Service (IHS), other Federal and State agencies, and local public and private organizations provide services to reservation residents. The public facilities and services in operation on the Crow Indian Reservation (described in detail by MWR-N, 1983, pp. 3-155 through 3-167 and 4-128 through 4-132) include the following:

- general government
- police
- fire
- hospital and health services
- social services
- mental health
- community health
- recreation

The Crow Indian tribal government has enough staff to meet the expected needs without any new mines. More staff, however, will be required by the police and various health-related services in both the mid-term (1995) and long term (2015). The need for personnel will increase fastest between 1982 and 1995 for all facilities and services, except social services and mental health, both of which have relatively constant rates of growth over the entire period.

The greatest increase in demand for personnel is expected to occur in hospital and health services, social services, and community health. For the long term, the total number of physicians needed will increase from five to twenty-one (320 percent), while the number of dentists needed will increase from two to five (150 percent). The combined number of personnel for social services, mental health, and community health will increase from six to fifteen (150 percent) through 2015.

Today's capital facilities for general government and police are adequate for forecasted conditions through 2015, but demands on hospital and health facilities and services will require additional capital facilities and equipment in both the mid- and long term. For capital facilities associated with community health, the rate of increase will be greater in the mid-term than in the long term. The rates of increase for social services and mental health facilities are expected to be relatively constant through 2015.

NORTHERN CHEYENNE RESERVATION

Social and community services provided on the Northern Cheyenne Reservation, described in the Northern Cheyenne Planning Office report (August, 1981), include—

- tribal government
- law enforcement
- health services
- water
- waste disposal
- fire protection

With the exception of tribal government, nearly all these services will require some expansion in the next few years. The necessary expansion can be attributed to a rapid, natural increase in population.

FISCAL CONDITIONS

SHERIDAN COUNTY

County Government

Sheridan County relies on both local and nonlocal sources of revenue. In the 1983–84 budget year, local sources provided about three-fourths of total revenues: The Sales and Use Tax accounted for about $1.5 million (26.2 percent), property taxes, about $0.8 million (26.2 percent) and interest, fees, and other local sources, about $1.5 million (22.4 percent). Nonlocal sources include intergovernmental transfers: revenue sharing, Federal payments in lieu of taxes (PILT), and State severance taxes (Mountain West Research-North, Inc. [MWR-N], 1983, pp. 3-243, 3-245; and Statement of Cash and Estimated Revenue Available for the Budget, Sheridan County, Wyoming, 1983–1985).

Sheridan County's ability to raise revenue has declined in real terms in recent years. That is, neither the property tax base nor retail sales have grown as fast as inflation (MWR-N, 1983, p. 3-245). Fortunately, the county has little debt: Most capital spending for growth has been funded from current revenues rather than through debt. As a result, future costs incurred by moderate growth will stem primarily from service, operation, and maintenance demands (MWR-N, 1983, p. 3-245).

Assuming no new mines open in the Decker area, total county revenues are projected to increase. Total expenditures are also forecast to increase steadily through time, eroding the net fiscal balance each year. However, all net fiscal balances are projected to be positive (MWR-N, 1985, p. 67).

City of Sheridan

Like the county, the city depends on both local and nonlocal revenue sources. The sales tax, considered local, is the largest revenue source, providing about one-third of the total. Other local sources, including property and other taxes, fees, and charges, provide about another third. The remaining third comes from nonlocal sources, principally intergovernmental transfers, such as State severance taxes and State and Federal grants (MWR-N, 1983, p. 3-279). Grant money is being used to fund a portion of capital projects (MWR-N, 1983, p. 3-275).

Together, sales tax receipts and other locally generated revenues just cover current operating and maintenance expenses. Nonlocal sources of revenue cover capital expenses. The city's dependence on nonlocal revenue could lead to financial problems in the future. The new facilities being funded with nonlocal revenues will increase future operating and maintenance costs. Any drop in nonlocal revenues could strain city standards of operations (MWR-N, 1983, p. 3-281).

Assuming no new mines open in the Decker area, the operating revenues available to the city are generally projected to be greater than operating costs over the next three decades. This net positive balance is mostly due to dependence on sales tax revenues, which are expected to grow along with population and the demand for city services. In the years for which major capital outlays are projected, however, expenses may exceed revenues, pushing the budget into the red. This decrease illustrates the city's dependence on outside revenues to fund capital facilities (MWR-N, 1983, pp. 4-201 and 4-202).

Dayton and Ranchester

Dayton and Ranchester are in a similar financial position: Each depends on nonlocal revenue sources over which it has little or no control. This dependence, combined with the failure of these sources to grow in step with population, could lead to financial shortfalls in the future. Local sources of revenue cannot be expected to make up the shortfalls, since (1) population limits potential sales tax revenues and (2) low assessed values limit both potential property tax revenues and bonding capacity (MWR-N, 1983, pp. 3-296 and 3-300).

In the recent past, general fund expenditures in Dayton have been greater than revenues, while in Ranchester they have been consistently less (MWR-N, 1983, pp. 3-296 and 3-300). In the future, Ranchester is projected to receive revenues sufficient to cover costs; however, capital facility construction is projected to push nearly balanced budgets into the red. Should the town lose any current sources of nonlocal funding, the situation would become much less manageable (MWR-N, 1983, pp. 4-208 and 4-209; 1985, p. 79). Dayton is projected to have positive net general fund balances, which will decline until 1992, when all projections show deficits in the future general fund balance (MWR-N, 1985, p. 85).

School Districts

Wyoming school districts pay almost all operational costs with a combination of local revenue and State equalization funds. Local revenues come from the district share of the 12-mill countywide school tax, district property taxes, and miscellaneous district, county, and Federal revenues. State equalization funds come mostly from property taxes.

School district 1, covering western Sheridan County, has had little growth in enrollment. But the district tax base, over the past three years, has grown annually, on average, about 17 percent. Despite the growth, the tax base remains, per student, less than in district 2.

The district 1 property tax levy includes a maximum, nonvoted, 25-mill operational levy and another 12-mill levy for debt payments on bonds (MWR-N, 1983, p. 3-249). District property tax revenues have increased in recent years. The portion of the countywide 12-mill levy received by the district, on the other hand, has remained nearly constant (MWR-N, 1983, p. 3-249).

School district 1 local revenue sources cannot pay for large increases in either operational or capital costs. The district already taps outside sources of capital, such as State and Federal loans and grants, since its bonding capacity is limited (MWR-N, 1983, p. 3-255). Moreover, although its tax base has grown, the district now gets more operating money from the State equalization program than in previous years. This increase stems from slower tax base growth in the county than in the State as a whole. The result is that, based on current rates of revenue receipts and per-student spending, the district is projected to have negative fiscal balances ranging from $5,000 in 1986 to $193,000 in 1996 to $288,000 in 2015 (MWR-N, 1985, p. 91).

School district 2, serving the Sheridan City area, is the largest school district in the county. Its tax base grew considerably between fiscal year 1981 (July 1980–June 1981) and fiscal year 1982. It then decreased, by about 8 percent, due to a lower valuation of public utilities. But per student, no net increase has occurred. The district mill levy stands at the nonvoted maximum, 25 mills. The debt-service levy has risen slightly in recent years to 5 mills (MWR-N, 1983, p. 3-255).

The dependence of district 2 on State equalization money has gone up in recent years. District and county revenues have stayed nearly constant, while State revenues have climbed considerably, from about one-third to one-half total annual revenues. The equalization money has risen because the educational cost per classroom unit (set by the Wyoming Legislature) has increased, while local resources have not. This condition has pushed up district eligibility for State equalization aid. With the recent passage of the constitutional amendment that shifts 6 mills from local to State control, a bigger part of future revenues may come from the State levy (MWR-N, 1983, p. 3-255).

Revenue and expenditure projectsions for school district 2 show healthy positive net balances, which decline from $401,000 in 1986 to a $29,000 deficit in 1995. Deficits are then projected to continue and increase to a level of $279,000 by 2015 (MWR-N, 1985, p. 97).

The third school district in Sheridan County, number 3, is not expected to be affected by the proposed mine and so is not discussed.

BIG HORN COUNTY

County Government

In fiscal year 1984 (July 1983–June 1984), about 85.4 percent of county general fund revenues came from local sources. The remaining 14.6 percent came from intergovernmental transfers. Property taxes were the largest local source, providing about $39 million (49.8 percent) of total revenues. Other local sources included licenses and service charges, fines and forfeitures, and miscellaneous revenues (Montana Association of Counties, 1985, p. 5).

The coal industry provided more than 80 percent of the Big Horn County property tax base in fiscal year 1982 (Montana Department of Revenue, 1983, p. 9). The largest source was the gross proceeds value of coal production, which is defined as 45 percent of the contract sales price per ton times the taxable tonnage sold.

The county tax base rises and falls with the rate of coal production and coal prices. Between 1981 and 1982, for example, the gross proceeds value rose from about $71 to $91 million, accounting for most of the change in total county taxable value from about $108 to $124 million (Montana Department of Revenue, 1983, p. 9). The increase was due primarily to expansion at the Spring Creek Mine. Because production fell sharply in 1982, 1983 gross proceeds taxable value fell to about $81.6 million, while the 1984 gross proceeds taxable value increased to $87.5 million.

In recent years, county spending has risen faster than inflation. Both total and per capita expenditures have grown on average about 20 percent per year (MWR-N, 1983, p. 3-88). The county is now taxing about 50 mills, including about 18 for the general fund, 12 for the road fund, 4 for the poor fund, and 3 for the bridge fund (Montana Association of Counties, 1985, p. 7). Since the general fund mill levy is limited to 25 mills, the county has about 7 more mills available to fund future cost increases.

Assuming taxes stay at current rates, the Big Horn County general fund is projected to have a surplus balance until 2011. Until that time, estimated fund balances increase to a peak in 1998 and then decline until annual deficits begin in 2011 (MWR-N, 1985, p. 103).

Incorporated Cities

None of the incorporated cities in Big Horn County are expected to be significantly affected by the proposed developments.

Crow and Northern Cheyenne Reservations

The proposed mine would not affect the fiscal condition of either reservation (MWR-N, 1983, pp. 8-45, 8-49), and so existing conditions are not described.

School Districts

School district expenditures would not be affected by the proposed mine, so existing conditions are not discussed here. Even without any new mines, the county would continue, through the remainder of the century, to pay more to the State school equalization program than it receives. Assuming existing mines close in the third decade of the 21st century, the county would then receive more State equalization aid than it contributes (MWR-N, 1983, p. 4-72; 1985, p. 112).

STATE REVENUES

Almost all revenue received by the State of Montana from coal development is based on the value of the coal sold. The State levies four main taxes: coal severance, Resource Indemnity Trust, a six-mill property tax (on the gross proceeds and other taxable base of the mine), and the Corporate License Tax (an income tax). The State also receives royalties from State-owned coal that is mined at the Absaloka and West Decker mines and half the royalties from federally owned coal.

The severance tax, 30 percent of the contract sales price, generates the most revenue for the State. (The contract sales price equals the gross sales price less production taxes and an adjustment for royalties paid.) Based on 1982 prices and projected production at existing Big Horn County mines, revenues from the severance tax would reach a maximum of $105.8 million per year between 1995 and 2009. After 2009, revenues would decrease to a low of $44.3 million in 2015 (MWR-N, 1985, p. 109). Total collections between 1985 and 2015 would amount to $2.8 billion (MWR-N, 1985, p. 109).

The Corporate License Tax is the next largest revenue producer. The tax is levied at the rate of 6.75 percent on the net income of corporations. Assuming a net income of 15 percent of gross income, collections would follow the same pattern as the severance tax. The total would amount to about $95 million between 1982 and 2015 (MWR-N, 1985, p. 110).

The Resource Indemnity Trust tax is 0.5 percent of the contract sales price of coal. Collections would again parallel the severance tax and amount to about $46 million between 1985 and 2015 (MWR-N, 1983, p. 4-31).

The State imposes a six-mill property tax on all real property in Montana to support the university system. Collections from this tax would once again follow the severance tax pattern and amount to about $24.8 million between 1986 and 2015 (MWR-N, 1985, p. 113).

Royalties on State-owned coal mined at the Absaloka Mine would amount to about $5 million over the next 15 years (MWR-N, 1983, p. 4-31). Federal royalties over the next 25 years would amount to about $430 million at the Decker Mine, about $380 million at the Spring Creek Mine, and about $5 million at the Big Horn Mine (MWR-N, 1983, p. 4-34). The State of Montana receives half the Federal royalties paid by the Decker and Spring Creek Mines and the State of Wyoming receives half of those paid by the Big Horn Mine.

FEDERAL REVENUES

In addition to royalties, the Federal government receives revenue from the corporate income tax, the Black Lung Excise Tax, and the Abandoned Mines Reclamation Tax. The corporate income tax has not been estimated, since it varies with year-to-year company profits. The Black Lung tax is calculated as 4 percent of the gross sales or f.o.b. (freight on board) price of the coal. At 1982 prices (MWR-N, 1983, p. 4-34), the tax amounts to about $0.60 per ton at the Big Horn Mine, about $0.72 per ton at the Decker Mine, about $0.63 per ton at Spring Creek Mine, and about $0.40 per ton at the Absaloka Mine. Over the 1986–2015 period, the tax would produce about $410 million. The Abandoned Mines Reclamation Tax is $0.35 per ton, and over the same period would produce about $240 million.

LAND USE PATTERNS

Land use patterns in Sheridan and Big Horn Counties changed little during the coal development period of the 1970s. Although declining slightly, agriculture remained the dominant land use. In Sheridan County, agricultural land made up 93 percent of the total in 1970 compared to 91 percent in 1980. In Big Horn County, the total changed from 87 to 86 percent (Mountain West Research-North, Inc. [MWR-N], 1983, p. 3-47).

The changes in land use were concentrated in towns and at minesites (MWR-N, 1983, p. 3-47). Growth outside incorporated areas has generally occurred in scattered parcels (MWR-N, 1983, p. 3-48). One new town, Spring Creek, was planned: It received the necessary permits, was platted, had streets cut to grade, and had sewer and water systems and trunk lines installed (MWR-N, 1983, p. 3-51). But the town never attracted any permanent residents.

The county seats, Sheridan and Hardin, have expanded their corporate boundaries through annexation. Growth in or near the two cities has been relatively orderly, because both cities enforce zoning and subdivision regulations (MWR-N, pp. 3-47, 3-48). In Sheridan County, Ranchester, Dayton, and the Big Horn area absorbed more than one-third of county population growth. The shift of land to residential development was the primary land use change.

The mines in Big Horn County today—Decker, Spring Creek, and Absaloka—cover 16,717 acres under permits granted by the Department of State Lands and the U.S. Office of Surface Mining (Department of State Lands, February 27, 1985). The permitted acreage has been, or will be, temporarily converted from agriculture to coal mining activities. This acreage makes up about 0.7 percent of county acreage (MWR-N, 1983, p. 3-49).

The minesite is located on the 25,192-acre CX Ranch (fig. 2-22 and table 2-15). The ranch is cow-calf operation that produces some surplus hay. At current agricultural productivity levels (table 2-15), the ranch would maximize profits with a herd size of 374 cow-calf units (Watts and Ingebrigtson, 1983, p. 27).

The 1,905-acre 12-year permit area covers about 5 percent of the irrigated alfalfa land, 36 percent of the improved pasture, and 7 percent of the rangeland on the ranch (table 2-15). The 12-year permit area would support about 30, or 8 percent, of the total cow-calf units (Watts and Ingebrigtson, 1983, p. 32).

Most of the irrigated alfalfa land is classified as prime farmland. About 14 acres of prime farmland would be disturbed by construction of the proposed railroad loop. (See chapter 3, Soils.)

TRANSPORTATION NETWORKS AND TRAFFIC FLOWS

ROADS AND HIGHWAYS

Sheridan County

Sheridan County has 46 miles of interstate (I-90), 62 miles of primary, 133 miles of secondary, 420 miles of county, and 403 miles of local or national roads (fig. 2-23). The minesite would be served by Wyoming sec-

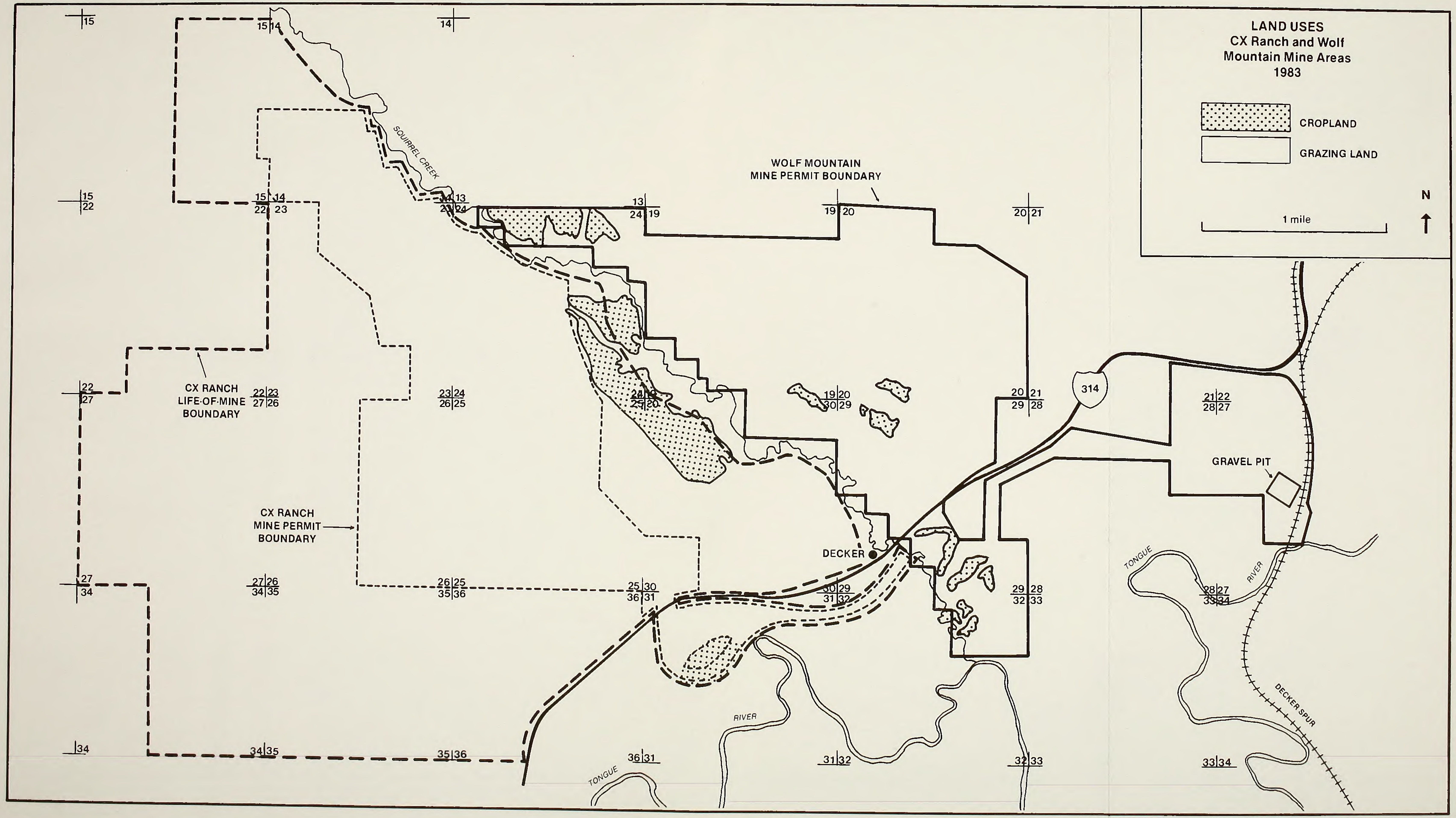


FIGURE 2-22 Most of the CX Ranch is grazing land, made up partly of improved pasture, but primarily of rangeland. Along Squirrel Creek and the Tongue River, the ranch also has cropland. Note that the drawing shows land uses only within or between the CX Ranch and Wolf Mountain Mine areas.

ondary route 338 (also known as the Decker Road), which is called Federal Aid Secondary 314 (FAS 314) when it crosses the border into Montana (Mountain West Research-North, Inc. [MWR-N], 1983, p. 3-29).

Wyoming 338 runs 14.5 miles between Sheridan and the Montana-Wyoming border. The route functions well for the terrain and vehicles now using the road. With scheduled improvements, the route, overall, will be safer and adapted to handle more traffic (Montana Department of Highways [MDOH], April 8, 1983, p. 3). Scheduled improvements include widening and reconstruction for all of the route that was not improved in 1982.

Between 1973 and 1981, traffic volumes on Wyoming 338 doubled, and in 1981 average daily traffic (ADT) stood at about 1,200 (MWR-N, 1983, p. 3-32). Coal development was responsible for a substantial share of the increase.

All mine employees living in Sheridan commute north along Wyoming 338 to work. The commuting pattern of Big Horn Mine employees, however, differs markedly from the pattern of Decker Mine workers. Nearly 60 percent of Big Horn workers drive alone, compared to less than 12 percent of Decker employees (Hooper and Branch, Jan., 1983, p. 37). The Big Horn Mine, as a result, generates twice as many vehicle trips per employee as the Decker Mine: The average vehicle going to the Big Horn Mine carries 1.7 passengers, while the average going to the Decker Mine carries 3.5 (Hooper and Branch, Jan., 1983, p. 37).

Sixty-nine accidents were reported on Wyoming 338 between January 1978 and January 1983, yielding an accident rate of 2.23 per million vehicle miles traveled. There were no deaths (MDOH, April 8, 1983, p. 3).

A transportation problem identified by Sheridan County officials is the lack of direct access from residential development south and west of Sheridan to U.S. Highway 87. This inaccessibility causes traffic congestion in downtown Sheridan during peak traffic periods. The West Beltway Highway, proposed by the county to relieve congestion, is the highest priority improvement now planned (MWR-N, 1983, p. 3-32).

The current coal train traffic going to and from the Decker area mines contributes to the traffic delay problems at crossings downline from the mines. For example, major delays now result at the grade crossing of Fifth Street with the Burlington Northern tracks within the city of Sheridan (ARIX, 1982, p. 3). About 16 trains a day (12 of which are unit coal trains) use the two tracks crossing Fifth Street (ARIX, 1982, p. 7). The Fifth Street crossing is blocked about 15 percent of the time, an 88-percent increase since 1978 (ARIX, 1982, p. 19). The impacts of the delays include—

- Reduced mobility for emergency vehicles.
- Aggravation and stress on drivers and passengers.
- High risk of vehicle, pedestrian and train collisions.

TABLE 2-15

Current Land Uses, Condition, and Productivity: CX Ranch, Proposed Permit Area, and Life-of-Mine Area

	Acres by Area					Average Productivity Per Acre					
	CX	Proposed 12-Year Permit Area		Life-of-Mine Area		CX Ranch		Proposed 12-Year Permit Area		Life-of-Mine Area	
Land Use	Ranch[1]	Total	Disturbed	Total	Disturbed	Actual	Potential	Actual	Potential	Actual	Potential
Irrigated alfalfa	374[4]	14	14	14	14	3.0 tons[1]	5.5 tons[12]	3.5 tons[5]	5.5 tons[5]	3.5 tons[5]	5.5 tons[5]
Improved pasture	466	170[2]	145	170	145	0.5 AMs[7]	0.9 AMs[11]	0.28 AMs[3]	0.9 AMs[11]	0.28 AMs[3]	0.9 AMs[11]
Rangeland	23,752[6]	1,721[2]	815	5,120	2,815	0.18 AMs[9]	0.27 AMs[8]	0.17 AMs[3]	0.36 AMs[3]	0.17 AMs[3]	0.36 AMs[3]
Cropland	600	0	0	0	0	30 bu[10]	35 bu[12]	30 bu[10]	35 bu[12]	30 bu[10]	35 bu[12]
TOTAL	25,192	1,905	974	5,304	2,974						

Note: All sources below refer to the CX Ranch Mine permit application (Consolidation Coal Company, 1984).

Abbreviations: AM = animal month; bu = bushel.

[1] Source: vol. 6, pp. 6-36c and 6-36d.

[2] Source: vol. 3, p. 3-82.

[3] Source: McAllister, OEA Research, written com., March 16, 1983.

[4] Includes 295 acres of alluvial valley floor significant hayfield; vol. 6, p. 6-36e.

[5] Source: vol. 6, p. 6-28.

[6] 40 percent of this acreage is Class III or poorer and is thus unsuitable for livestock grazing. AUM figure is for suitable acreage only; vol. 6, p. 6-36d.

[7] Based on 816.7-acre intensive study area; vol. 13, pp. 260a and 260b.

[8] Based on 5,049-acre intensive study area; vol. 13, pp. 257-260a.

[9] Based on 5,049-acre intensive study area; vol. 13, pp. 21 and 45.

[10] Source: vol. 13, p. 40.

[11] Source: vol. 9, pp. 21–23; vol. 13, p. 48; Soil Conservation Service, 1971, pp. 128–133.

[12] Source: Soil Conservation Service, 1971, pp. 128–133.

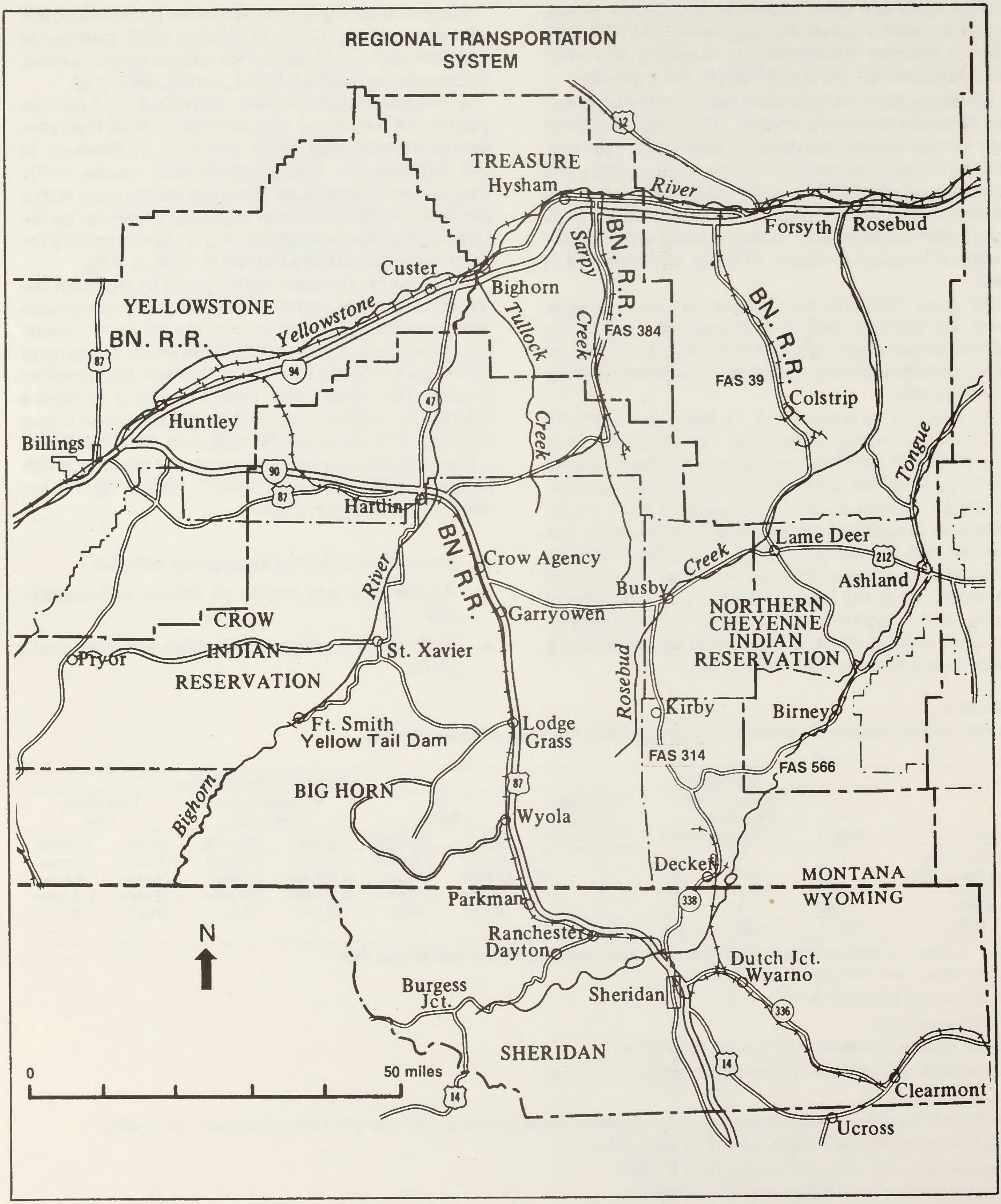


FIGURE 2-23 The road most affected by mining in the Decker area would be the Decker highway, called route 338 in Wyoming and route 314 in Montana. The railroad serving the mine would be the Decker Spur, branching from the Burlington Northern main line at Dutch Junction.

- Reduced access to northeast Sheridan.
- Reduced mobility for pedestrians crossing the railroad tracks.
- Traffic congestion at the intersection of Broadway and Fifth Street (ARIX, 1982, p. 3).

The county and Burlington Northern have discussed construction of the grade crossing. However, no construction plans have been finalized (MWR-N, 1985, p. 19).

Big Horn County

Big Horn County has 81 miles of interstate (I-90), 79 miles of primary, 160 miles of secondary, 900 miles of county, and 375 miles of Indian and national roads (MWR-N, 1983, p. 3-29). (See fig. 2-23.) The minesite would be served from the south via FAS 314. FAS 314, classified as a major collector, functions well for the terrain and vehicles now using the route. The route was recently improved and, barring serious, unforeseen deterioration, further improvements before 1988 are unlikely (MDOH, April 8, 1983, pp. 1 and 2).

Between 1973 and 1981, traffic on FAS 314 south of Decker increased 70 percent (MWR-N, 1983, p. 3-32). Average daily traffic (ADT) in 1983 was about 406, a decrease from 553 ADT in 1981 (MDOH, 1983, p. 152). In the first 6 miles of FAS 314, 20 accidents took place between January 1, 1978, and December 31, 1982. This data yields an accident rate of 1.69 per million vehicle miles traveled, compared to a statewide average for secondary routes of 2.83 (MDOH, April 8, 1983, pp. 2 and 3).

The northern 5 miles of FAS 314, just south of where the road intersects U.S. 212 near Busby (fig. 2-23), was reconstructed in 1983. The 6.3 miles north of Kirby are now scheduled for reconstruction beginning in 1988. There will be about 11 miles between the two sections that will not be upgraded.

RAIL NETWORK

A Burlington Northern mainline runs north-south through Big Horn County. The section starts in Huntley, Montana, and joins Hardin, Lodge Grass, and Sheridan. Traveling the section each day are 24 to 28 trains (12 to 14 each way), of which 4 (2 each way) are unit coal trains (MWR-N, 1983, p. 3-32). Unit coal trains are typically 100 cars long.

From Sheridan, the Burlington Northern mainline runs east through Clearmont to Gillette, where the tracks split to points south and east. Daily traffic east of Sheridan includes 8 merchandise freight trains, 4 each way (MWR-N, 1983, p. 3-32).

A spur line, approximately 19 miles long, connects the West Decker Mine with the Burlington Northern mainline at Dutch Junction, about 5 miles east of Sheridan. The spur then extends northwest from the Decker Mine to the Spring Creek Mine (See fig. 2-23.)

Approximately 4.4 million tons of coal per year are shipped south to Texas from the Decker area mines. The other 12.3 million tons per year produced brings about 2,460 unit coal trains per year—about 4 per week—(1,230 each way) through Sheridan.

OUTDOOR RECREATION

Bighorn Canyon National Recreation Area, Bighorn National Forest, and Custer National Forest provide the bulk of land for outdoor recreation in the region surrounding the CX Ranch (fig. 2-24). Added to this in Big Horn County are four fishing access sites, the Tongue River Reservoir, and several historic preserves. In Sheridan County there are several more historic sites, four wildlife management areas, and one camping site. (See app. B, table B-15 for a complete list.)

Taken as a whole, the capacity of regional outdoor recreation areas appears adequate to accommodate all future recreation demand (Mountain West Research-North [MWR-N], 1983, p. 4-43). For example, Montana Department of Fish, Wildlife and Parks estimates of statewide recreation rates and trends indicate that the supply of recreation areas is adequate. Bighorn National Forest supply and demand data lead to similar conclusions. Thus, population growth in the absence of new mine development will not, on a regional level, cause overcrowding or overuse of outdoor recreational areas, based on the capacity levels and management objectives of State and Federal agencies.

In local areas, in contrast, some impacts may arise. Unequal distribution of people (over the days of the week, months of the year, sites, and activities) will cause overcrowding. Some camping and picnic areas in Bighorn National Forest already reach capacity on weekends. In the Cloud Peak Primitive Area, foot trails are traveled heavily, more than anywhere else in Bighorn Forest. At the Bighorn Canyon National Recreation Area, where an estimated 77 percent of visitors come from Wyoming and Montana, camping and boating sites reach capacity during five to six weekends each year (MWR-N, 1983, p. 4-43).

Similar unequal demand will probably prevail in the future. Regardless of the number of places to go, people tend to stay close to home, seek areas with environmental diversity, and show more interest in undeveloped recreation. Use does not spread evenly. The condition of the land and facilities at popular sites can thus be expected to worsen.

Another likely future problem will be conflicts among different recreation groups and between recre-

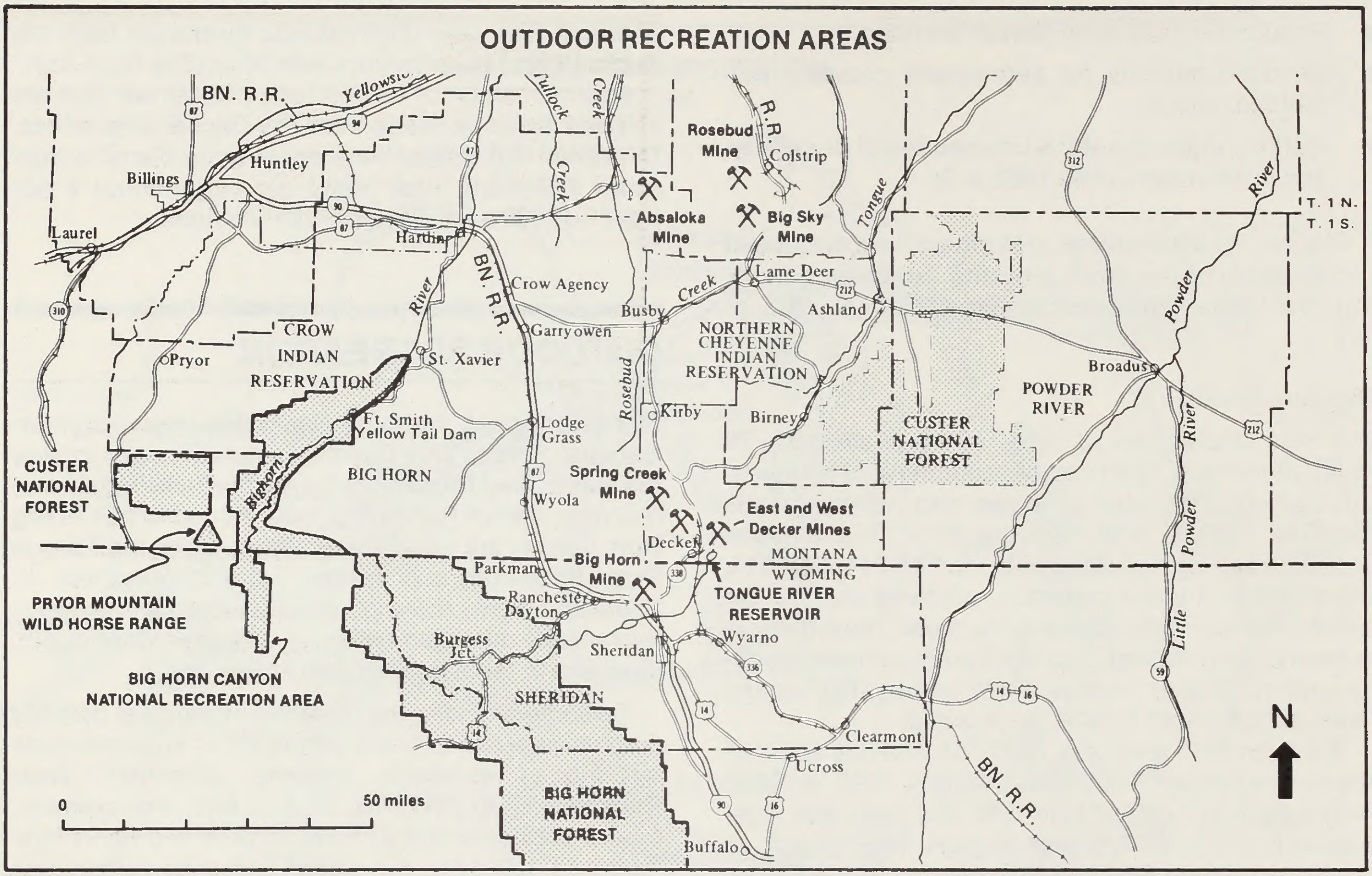


FIGURE 2-24 Many outdoor recreation sites lie near the mine. Shown here are only the major areas, such as Bighorn and Custer National Forests. Not shown are the many local fishing and camping sites and the numerous scattered parcels managed by the Bureau of Land Management.

ationists and private landowners. Already, population increases in Sheridan County are perceived as contributing to conflicts. More and more private landowners charge a “trespass” fee to offset damages by a growing number of sportsmen who want hunting and fishing access. Long-time resident hunters and fishermen generally perceive a decline in the number of big game and fish. Outfitters and hikers have expressed animosity toward each other: On the one side, outfitter base camps are damaged or robbed, and on the other side, trails have become rutted and messy from horse traffic. Tension will probably continue in the future, even without the development of new mines (MWR-N, 1983, p. 4-44).

Still another recreation problem today is crowding. Whether real or imagined, this problem lowers people’s satisfaction with recreation. Tolerance for contact with others varies between people and among groups. But with a growing population, the perception of crowding will intensify. Even now there is the issue of whether or not the Cloud Peak Primitive Area and the national forest may become too crowded to provide ample isolation, a prime benefit of wilderness (MWR-N, 1983, p. 4-44).

Thus, while projections of demand leave sufficient overall recreation capacity for a growing population, the distribution of people to prevent overcrowding at some sites presents a critical problem for recreation managers.

CULTURAL RESOURCES

Archaeological surveys (see introduction) have identified 141 prehistoric sites, 23 historic sites, and 54 isolated or minor items in a 22,420-acre study area that includes and surrounds the CX Ranch 12-year permit area. Eighteen prehistoric and two historic sites are located on the lands being considered for permitting. Of the total recorded sites, 15 of the prehistoric and 3 of the historic sites are considered eligible for listing on the National Register of Historic Places by either a consultant (Historic Research Associates [HRA]), the Montana State Historic Preservation Office (SHPO), the U.S. Office of Surface Mining (OSM), or the Keeper of the National Register of Historic Places (table 2-16).

Many kinds of sites are represented on the lands studied: rock shelter habitations, open campsites with or without stone circle features, a bison kill, prehistoric rock art, stone quarries, stone workshops and manufacturing sites, homesteads, ranch sites, and an early schoolhouse now used as a community center.

Porcellanite (a type of rock) was evidently important as a raw material used in prehistoric toolmaking, because porcellanite artifacts dominate most prehistoric sites in the study area.

Most of the historic sites in the study area are homesteads dating to the 1887-1927 period. Other historic sites give evidence of small, family coal mines, ranch outbuildings such as granaries, and gravel-loading facilities. The historic sites most likely to be eligible for the National Register are those that best illustrate the 1890-1910 settlement period.

Certain unrecorded or otherwise unknown cultural resource sites—typically hills, lakes, or forest glades—are sacred to American Indians. In recognition of the inherent right of these Indians to believe, express, and exercise their traditional religions (including the right to maintain access to sacred places), Congress passed the American Indian Religious Freedom Act in 1978 (AIRFA: 92 Statues 469, 42 USC 1996). The act requires the Office of Surface Mining and encourages state regulatory authorities to monitor potential unnecessary interference with Indian religious practices by a mining company in the course of mining. The Office of Surface Mining encourages Indian tribes to identify both those sites mining may destroy and those sites whose free access may be interfered with. Operation of Consol's proposed CX Ranch Mine would fall under the jurisdiction of the provisions of AIRFA.

AESTHETICS

The site of the CX Ranch Mine covers gently sloping rangeland and steep, flat-topped bluffs. The lower part of the site lies in the flat bottom of Squirrel Creek valley. In places, 10- to 50-foot-high sandstone crags (eroded into various formations) rise from the surrounding rangeland. The higher parts of the minesite, reaching as high as 300 feet above the creek, span dissected ridges and knolls. These high points are flanked by eroded slopes sometimes banded by tan and bleached-red soil layers.

A variety of vegetation covers the minesite. Along the creek lies cropland, bordered by occasional cottonwood trees. On the gentle slopes are shrubs, such as sagebrush, and grasses. On the steep slopes is a mixture of shrubs, grasses, and small patches of juniper and ponderosa pine trees.

The vegetation pattern appears spotty and irregular. Colors range widely: Grasses are typically light green, shrubland, blue-green; and the juniper and pine trees dark green. In places the juniper and pines extend in a band along the slopes of the high bluffs. Bare soil and jumbled clusters of rocks lie interspersed throughout the minesite.

The area contains few structures: scattered houses, barns, and outbuildings, built from a variety of materials. Other manmade structures include fencelines,

TABLE 2-16

Cultural Resource Sites Potentially Eligible or Eligible for Listing on the National Register of Historic Places

Site Number	Site Name	Description	National Register Location	Eligibility Status
24BH1001	Foss-Thomas	Bison kill site/campsite	Permit area	Determined 3/11/82[1]
24BH1030	Sandy Mesa	Campsite	Permit area	Determined 3/11/82[1]
24BH1944	— —	Lithic workshop/ porcellanite procurement	Permit area	SHPO recommends
24BH1949	Powers	Tipi rings/campsite	Permit area	Determined 3/11/82[1]
24BH1950	Powers Petroglyph Shelter	Rockshelter, petroglyphs, open campsite	Permit area	Determined 3/11/82[1]
24BH1959	—	Porcellanite workshop, rock pile, possible tipi ring camp	Intensive area[2]	Needs more testing
24BH1973	Solo Rock Shelter	Rockshelter	Intensive area	Recommended by HRA
24BH1975	Squirrely	Buried campiste	Intensive area	Determined 3/11/82[1]
24BH2091	—	Campsite/porcellanite procurement/sandstone feature	Permit area	Needs more testing
24BH2109	—	Porcellanite workshop	Intensive area	SHPO & OSM recommend
24BH2111	—	Porcellanite workshop	Intensive area	SHPO & OSM recommend
24BH2113	—	Campsite/lithic workshop	Intensive area	SHPO recommends
24BH2123	Squirrel Creek School	School	Intensive area	SHPO & OSM recommend
24BH2128	CX Ranch	Ranch	Buffer area[3]	SHPO & OSM recommend
24BH2136	McCarthy Ranch	Ranch	Buffer area	SHPO & OSM recommend
24BH2137	—	Campsite/stone structure	Intensive area	SHPO & OSM recommend
24BH2145	—	Campsite	Intensive area	More testing needed
48SH412	—	Petroglyphs	Buffer area	No information available on Wyoming SHPO recommendations

Note: SHPO = State Historic Preservation Office; HRA = Historic Research Associates; OSM = Office of Surface Mining.

[1] Sites determined eligible for the National Register by the Keeper of the Register.

[2] Intensive area is the part of buffer zone intensively surveyed. The buffer zone is the area included in a one-mile band around permit area.

[3] Buffer area is the part of buffer zone not intensively surveyed.

power poles, unimproved farm roads, and the gravel road leading to the CX Ranch headquarters. These manmade changes are subtle, blending with the ranching landscape, typical of this part of the West.

The scenery surrounding the minesite is pleasing and interesting—steep breaks, prominent sandstone formations, patches of sparse forest, and occasional deciduous trees. In the distance are views of the Big Horn Mountains, Wolf Mountains, and the Tongue River Valley, which lend variety to the otherwise uniform landscapes.

Most of the vistas and features are typical of southwestern Montana. More scenic landscapes border the Big Horn Mountains and the Ashland division of Custer National Forest. Less scenic areas, particularly mined lands, are also located nearby.

Since the minesite is surrounded by bluffs, most of it cannot be seen from far away. One exception is the view from the Decker highway, which runs along the southern border of the 12-year permit area. For four miles, highway travelers can see the minesite. The majority of traffic stems from the Spring Creek and Decker Mines to the north. The minesite is also visible from isolated sections of rural roads across the Tongue River (to the southeast) in Wyoming.

The minesite is closed to public use; recreationists cannot enter and visit the CX Ranch. However, some traffic passing near the site on the Decker highway is recreational.

CHAPTER

3

IMPACTS OF THE PROPOSAL

The impact analysis covers 20 topics, describing subject by subject the consequences of mining. At the start of each topic is a summary of the major impacts expected. Following the summary is a detailed discussion of the impacts. Each topic ends, when appropriate, with a list of "mitigating measures," or actions that could be taken to reduce or eliminate the adverse impacts projected. All of the actions listed as mitigating measures are suggestions by the agencies, not proposals by Consolidation Coal Company.

The EIS analysis covers three levels of mine development: Consol's proposed (12-year) plan, Consol's life-of-mine (33-year) plan, and the cumulative scenario (the maximum amount of mine development expected in the area). (See introduction.) The analysis thus makes projections for an array of future possibilities ranging from a modest, short-term, local expansion of mining to an enormous regional expansion. Included in the analysis are projections not only of direct impacts, such as minesite soil removal, but also indirect impacts, such as job growth resulting from population expansion.

Note that the agencies do not embrace any one of the three levels of development as a vision of the future. The three levels merely illustrate what is possible, based on the plans and possible intentions of Consol and other energy companies. How much development actually occurs in the future will depend largely on coal demand and prices, which cannot be predicted accurately.

GEOLOGY

Summary of Impacts: After mining, the topography of the minesite would be slightly smoother than today. Minor gullies would probably develop, but would not restrict postmining land uses. Erosion rates would probably be the same as or less than existing rates. Impacts from unsuitable overburden would be minimal.

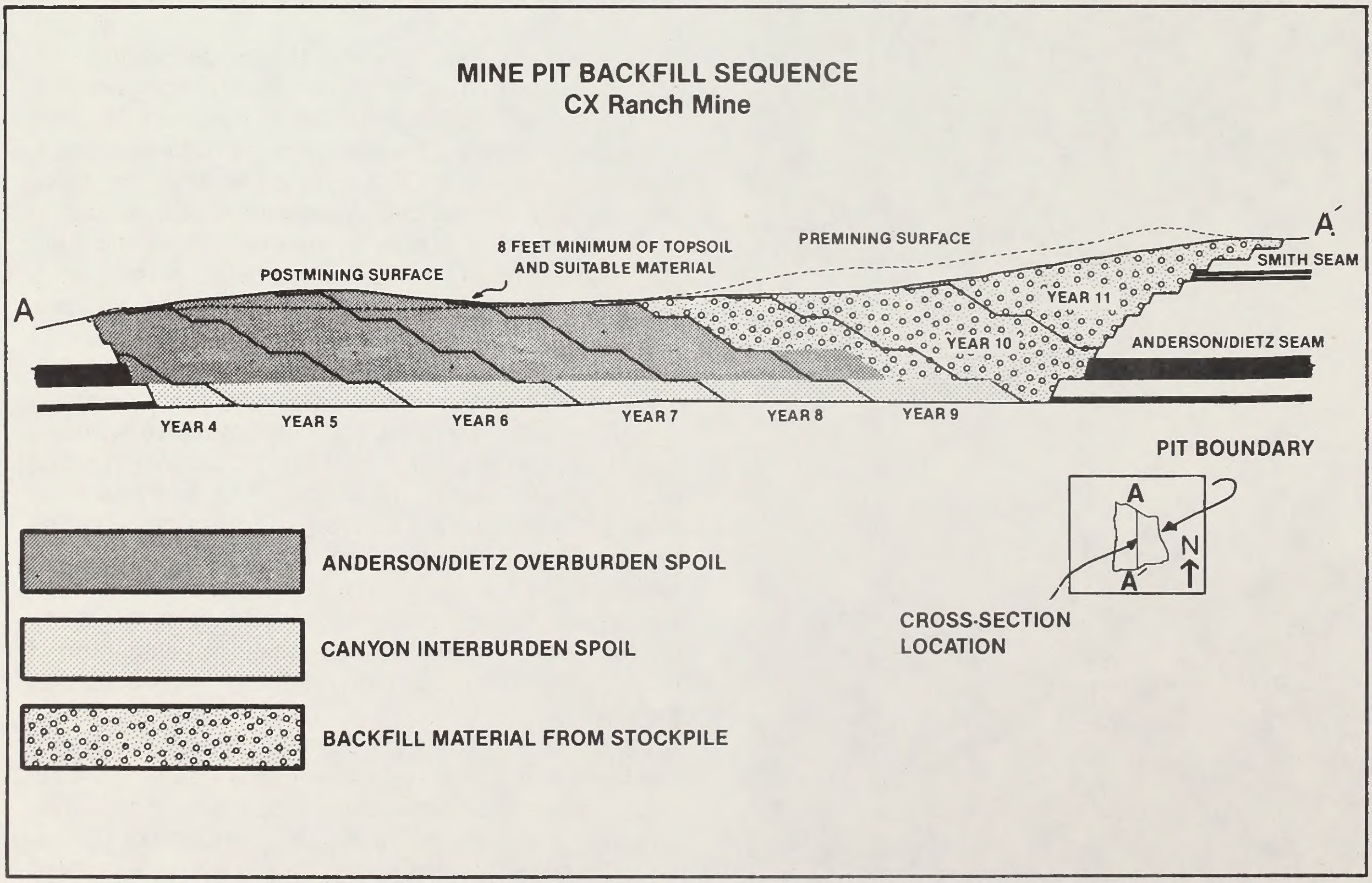
TOPOGRAPHY AND GEOMORPHOLOGY

The postmining topography would resemble the existing topography. In general, postmining slopes would be as or less steep than natural slopes. The postmining topography would be slightly higher to the north (toward Squirrel Creek) and slightly lower to the south (fig. 3-1). The topography would change for two reasons: Steep slopes along the southern margin of the mine would not be rebuilt, primarily because the unconsolidated spoil (replaced overburden) would erode more easily than the existing steep slopes underlain by bedrock. Second, the new topography would maximize direct backfilling. The technique of direct backfill (taking overburden from new mine areas and dumping it directly into the mined-out pit) speeds reclamation and minimizes temporary spoil stockpiling. The result would be less disturbance and lower operating costs.

Erosion rates after mining would generally exceed premining levels until an adequate vegetative cover is established. Erosion would then decrease significantly. As a general rule, overall erosion rates would probably approach or be less than premining rates two to three years after initial revegetation. Sedimentation ponds would be located in every drainage that would be disturbed, limiting sedimentation effects to the minesite.

Despite the anticipated overall success of Consol's mine plan in controlling erosion, localized problems could develop. The removal of bedrock during mining, for example, could cause gullying where bedrock no longer restricts downcutting by water. Similarly, several small draws not reconstructed during reclamation could redevelop over time as the drainage network ex-

FIGURE 3-1 The mine pit would be backfilled with spoil (excavated overburden and interburden) as soon as the Canyon coal is removed. Note that the most permeable spoil, the Canyon interburden, would be placed along the bottom of the pit. (For the orientation of the pit within the permit area, refer to figure 3-2.)



pands. (See Mitigating Measures.) During the period after reclamation and before bond release, the company would be required to fill in and revegetate any gullies deeper than 9 inches. After bond release, channel development would go unmitigated.

Gullies can decrease the amount of vegetated area and can reduce vegetative productivity next to the gully. Gullies can also limit access and degrade downstream water quality (Heede, 1982). At the CX Ranch, small gullies exist naturally and have not appreciably affected man's use of the land. The gradual development of small gullies on reclaimed land would therefore probably be insignificant.

Consol would construct 18 sedimentation ponds, at least one in every disturbed drainage, to confine eroded sediment to the minesite. Based on information from operating mines, little, if any, minesite sediment would travel beyond the sediment ponds. The ponds would not be removed until erosion rates are comparable to or less than premining rates. (See Soils.) As such, mining would not significantly increase sediment loads in Squirrel Creek or the Tongue River.

Sedimentation ponds could increase downstream channel erosion by trapping stream-carried sediment. The clarified pond water would again pick up sediment and therefore cause erosion downstream (Pazwash, 1982). The result would be a widening and downcutting of the stream channel just below the ponds. The channel would erode only a small amount, however, because the sediment ponds would be temporary and the drainage area above the pond small.

The sediment ponds would also cause sediment deposition upstream. Once the ponds are removed, the stored sediment would erode. This could temporarily slow plant growth where the sediment settles, although the amount of land affected would be small. Overall livestock and wildlife use would remain unaffected.

STRUCTURE AND STRATIGRAPHY

The stratigraphy within the mine pit would be destroyed; however, the strata have no special qualities or intrinsic value. The confined coal aquifers would be replaced with a mixture of broken, loose rock, resulting in some degradation of ground water quality. (See Hydrology.)

PALEONTOLOGY

Mining would have no impact on paleontological resources (fossils). No known paleontological resources of importance have been found in the Decker area and the potential for important finds is low.

OTHER MINERALS

Mineral resources other than coal would not be significantly affected by mining at the CX Ranch. Mining would not preclude development of oil or natural gas from lower strata.

OVERBURDEN

Suitable Overburden Handling Plan

After reclamation, the top 8 feet of the spoil (replaced overburden) and soil acts as the rootzone for vegetation. It also acts as a buffer, protecting new vegetation from potentially toxic underlying spoil. To isolate material that is appropriate for the rootzone, the company must distinguish between "suitable" and "unsuitable" overburden during overburden salvage. When the mine pit is backfilled, only suitable material should be replaced at the spoil surface, which is then covered with soil. (Suitable, as used here, means physically and chemically favorable for plant growth.)

To formulate a plan for separating suitable from unsuitable overburden material in the field, Consol geologists attempted to correlate overburden chemical properties with major lithologic units in the CX Ranch area. However, all chemical-lithologic correlations proved unreliable among core hole locations. As a result, Consol developed an overburden handling plan unrelated to chemistry-lithology correlations. The plan calls for examining only the top 25 feet of overburden in gently sloping alluvial and colluvial areas. This plan would provide adequate amounts of suitable overburden for the postmining rootzone.

Table 3-1 shows weighted averages of physiochemical characteristics for the top 25 feet of five overburden cores located in gently sloping alluvial and colluvial zones in and around the proposed disturbance area. (See chapter 2, fig. 2-4.) Consol used this data, in addition to data from a number of cores surrounding the disturbance area, to determine the 25-foot salvage depth. The company found that overburden in bedrock-controlled areas (where overburden formed in place) tended to be highly sodic. However, the top 25 feet of all overburden cores in alluvial and colluvial areas within and adjacent to the disturbance area contained, with few exceptions, desirable chemical and physical properties.

Consol's plan to consider only the top 25 feet in alluvial and colluvial areas is the first step of a process aimed at assuring that spoil of adequate quality is replaced in the rootzone during reclamation. In a second step, suitable overburden material within the top 25 feet would be delineated by sampling and analysis. In a third step, the material, once replaced in the rootzone, would be sampled and analyzed again.

During the second step, the presalvage analysis, the sampling would be done on a grid consisting of one hole per two acres. The samples would be taken from cuttings that are a product of overburden drilling for explosive placement and blasting. Consol would measure pH (the degree of acidity or alkalinity), saturation percentage (an indicator of water-holding capability and the presence of swelling clays), and sodium adsorption ratio (sodicity). Material determined as ade-

TABLE 3-1

Weighted Averages of Physiochemical Characteristics for the Surface 25 Feet of Overburden in and Around the Area Proposed for Suitable Overburden Selection

Core Number	pH	EC[1] (mmhos/cm)	Saturation %	Na	Ca	Mg	SAR[3]	ESP[4]	% Sand	% Silt	% Clay	Texture[5]	Acid-Base Potential[6]
				meq/l[2]									
CX-79-3	7.7	1.9	53	2.0	8.5	8.4	0.7	—	57.2	21.6	21.2	SCL	+56
CX-79-6	8.4	1.5	81	10.0	1.2	4.3	6.9	8.1	61.8	20.6	17.6	SL	+81
CX-79-11	8.3	2.0	89	14.0	1.3	2.8	10.6	12.8	70.4	14.2	15.4	SL	+56
OB-1	8.1	1.5	49	9.6	1.8	4.7	5.2	—	68.1	18.7	13.2	SL	—
OB-5	8.3	1.5	61	15.3	3.2	4.9	15.3	—	34.9	51.3	13.8	SiL	—

Core Number	SO$_4$	B	Cu	Fe	Pb	Mn	Zn	Ni	Cd	Se	Hg	Mo	NO$_3$-N	NH$_4$-N
	parts per million[7]													
CX-79-3	290	0.7	1.1	18	2.9	9.7	73.0	0.8	0.11	>0.01	0.03	0.1	3.9	6.8
CX-79-6	398	0.3	0.6	6	0.6	7.8	4.7	0.3	0.06	0.01	0.03	0.0	0.7	5.5
CX-79-11	662	0.3	0.5	5	1.1	2.5	1.7	0.1	0.03	0.02	0.02	0.0	5.9	3.2
OB-1	—	—	—	—	—	—	—	2.6	—	—	—	0.3	—	—
OB-5	—	—	—	—	—	—	—	5.4	—	—	—	0.4	—	—

Note: Consol proposes to use some of the top 25 feet of overburden material taken from the gently-sloping colluvial/alluvial areas for rootzone reestablishment during reclamation. The core data given above are from gently sloping colluvial/alluvial areas; however, Consol used the data from the top 25 feet of cores from all areas to establish a trend in suitable salvage depth.

— Indicates no data available.

[1] Electrical conductivity (a measure of salinity) in millimhos per centimeter.

[2] Milliequivalents per liter; Na = sodium, Ca = calcium, Mg = magnesium.

[3] Sodium adsorption ratio (a measure of sodicity).

[4] Exchangeable sodium percentage (a measure of sodicity).

[5] SCL = sandy clay loam, SiL = silt loam, SL = sandy loam.

[6] Units = ± tons of calcium carbonate equivalent per 1,000 tons of overburden material.

[7] SO$_4$ = sulfate, B = boron, Cu = copper, Fe = iron, Pb = lead, Mn = manganese, Zn = zinc, Ni = nickel, Cd = cadmium, Se = selenium, Hg = mercury, Mo = molybdenum, NO$_3$-N = nitrate nitrogen, NH$_4$-N = ammonium nitrogen.

quate for reclamation would be placed in the suitable overburden stockpile.

If test results show that some of the overburden is unsuitable, the material would not be placed in the suitable stockpile. Further testing would then be done in the immediate area to delineate the extent of the suspect material. Consol could be required to map unsuitable overburden areas for agency review. Material found inadequate would be placed in the primary overburden stockpile. During reclamation, the inadequate material would be buried in the pit beneath the rootzone and above the postmining aquifer. (See Hydrology.)

During the third step, the postmining regraded spoil analysis, Consol would analyze for pH, saturation percentage, electrical conductivity (salinity), sodium adsoption ratio, and texture. Samples of regraded spoil would be taken to a depth of 8 feet. Each 8-foot sample would be split into two equal increments for analysis. Sampling locations would be centered on a 2-acre grid system over the regraded areas. Any material found unsuitable would be removed and replaced. Together with the 25-foot selection plan and the presalvage analysis, the postmining spoil testing program would greatly decrease the possibility of permanently placing undesirable material in the rootzone.

Clay Mineralogy and Sodicity

Clay mineral analysis by x-ray diffraction of four samples from four different drill cores shows that smectite, a swelling clay, dominates two samples. Placed at or near the surface during reclamation, materials containing swelling clays may deteriorate and form a surface crust, resulting in decreased water infiltration and permeability, and decreased root penetration (Klages and Hopper, 1982). The extent of this deterioration depends on the amount of swelling clays in the clay fraction.

Combined with high sodium levels, smectite-dominated rootzone overburden can deteriorate good-quality cover soil due to upward migration of sodium. The sodium migrates upward by diffusion through soil water. The diffusion occurs because the low hydraulic conductivity of the buried spoil precludes water movement down through the spoil (Merrill et al., 1980). The possible adverse effects on plants of highly sodic materials are discussed extensively in the literature (Schafer, 1982; Bresler et al., 1982; Sandoval and Gould, 1978; Bernstein, 1975).

Overburden materials with high SAR values and high saturation percentages exist at the CX Ranch minesite. To identify overburden that could cause sodicity- and smectite-related problems, Consol field reclamation specialists would examine saturation percentage and sodium adsorption ratios (SAR) during the presalvage and postmining overburden/spoil sampling programs. An SAR value of about 13 or greater indicates excess sodium, and a saturation percent of greater than 85 indicates that an excess of swelling clays may be present. Consol would bury below the rootzone any spoil with these unsuitable characteristics.

If measures were not planned to provide a suitable soil/spoil rootzone, reclamation could fail. That is, if soils containing swelling clays and elevated sodium levels were placed over spoil with similar properties, the vegetation would not become established. However, based on Consol's soil and overburden handling and sampling programs, these extreme conditions are highly unlikely at the CX Ranch.

Trace Elements

Overall, trace element concentrations in CX Ranch overburden are very low. (See chapter 2, table 2-2.) Nickel is present at concentrations greater than 1 part per million (ppm) in several drill-sample increments. Although under certain conditions concentrations above 1 ppm could be toxic to some plants, these conditions are not present at the CX Ranch. Metallic elements such as nickel are most soluble and therefore available to plants under acid soil conditions; the solubility of such elements is greatly reduced under alkaline soil conditions like those found in southeastern Montana (Munshower, 1983; Lisk, 1972; Vanselow, 1966). For this reason, nickel is no longer included in the Department of State Lands draft 1983 list of suspect levels for soils and overburden, and no nickel toxicity is anticipated at the CX Ranch Mine. Nickel toxicity in plants and animals is primarily associated with industrial activity such as smelters (Munshower, 1983; Barth et al., 1981; Gough et al., 1979).

MITIGATING MEASURES

- To minimize the possibility of gully development on the reclaimed landscape, Consol could add additional small (order 0 and 1) tributary draws, thereby creating a denser drainage network.

HYDROLOGY

Summary of Impacts: The CX Ranch Mine would have two main hydrologic effects: First, mining would change water levels and water quality in wells near the mine. Three wells would be removed by the mine and six more would probably be affected by water level declines or water quality deterioration. Any wells rendered unusable by mining would be replaced by the company.

Second, pit water discharge would worsen surface water quality of Squirrel Creek and the Tongue River. Discharges would probably double or triple the creek's average ammonia concentrations, although greater temporary increases are likely. Nitrate concentrations would probably increase even more. Sodium levels would increase dramatically. Ammonia and nitrate/nitrite concentrations in the Tongue River would also rise, but much less than for Squirrel Creek (under 5 percent in average conditions; up to 30 percent in extreme circumstances). Development of up to 11 mines above the Tongue River Reservoir could more than double ammonia and nitrate/nitrite concentrations in the river.

GROUND WATER

Mining at the CX Ranch Mine would remove or cover three wells. One of the wells is a domestic water source; the other two are now unused. (See app. D, table D-2, wells 5, 3, and 6.) Mining would also lower potentiometric levels for up to 2 miles around the mine pit (table 3-2). (The potentiometric level is the height to which water will rise in a well.) The area of drawdown already created by the West Decker Mine would be thereby extended about 3 miles southwest.

As a result of drawdown, the levels in up to 11 wells tapping the Anderson, Dietz 1, Dietz 2, Canyon, or Wall coal seams could decline during mine operation. Eight of the eleven wells may not be affected appreciably because faults that appear to restrict ground water movement lie between the minesite and the wells. Water levels in the remaining three wells would decline 25 to 100 feet. One is a domestic well, one a stock well, and the third is unused. (See app. D, tables D-2 and D-3, wells 41, 42, and 4.) All but two of the 11 wells that could be affected are owned by either Consol or the Decker Coal Company. The two private wells serving the Decker Store and post office and another well serving the Squirrel Creek School are across the fault and are unlikely to be affected. (See app. D, table D-3, wells 39 and 40.)

TABLE 3-2

Maximum Declines in Ground Water Levels

Aquifer	Current Water Column[1]	Declines at Various Distance from Mine Pit 1,000 feet	1 mile	2 miles
Anderson/Dietz	135-150 feet	115	25	10
Canyon	350-400 feet	160	35	20

Source: Consolidation Coal Company, 1984.

Note: Maximum declines would occur in year 9.

[1] Average height of water in minesite (potentiometric elevation) as measured in a well from the bottom of the aquifer.

The drawdown would result from water flow into the mine pit. The calculated rate of inflow during the early years of mining would normally range between 200 and 350 gallons per minute (gpm), peaking as high as 500 gpm (1.1 cubic feet per second [cfs]). Most inflow would come from water draining the two coal aquifers (water-bearing strata) cut by mining. Some pit inflow would also come from the Squirrel Creek alluvium (stream-laid deposits).

Flow into the pit from the alluvium would not significantly affect the irrigated agricultural fields adjacent to the mine. The largest alluvial inflow (50 to 60 gpm in year 3) would occur when the pit intersects small portions of the alluvium. Ground water levels in the Squirrel Creek alluvium would then decline about 2 feet at 2,000 feet from the mine pit. Normal water levels lie 14 to 20 feet below the land surface in this area, indicating that subirrigation probably is not important to plant growth. Since water level declines in the alluvium would rapidly decrease away from the mine, no subirrigated agricultural fields would be affected. After year 4, alluvial ground water inflows would gradually decrease, dropping to less than 5 gpm as the mine moves away from Squirrel Creek and the original mine pit is backfilled.

Blasting of overburden and coal seams could increase turbidity and gases in the water supplying up to four wells not owned by mine companies. Blasting might also structurally damage poorly constructed or corroded wells near the mine. One domestic well (owned by James Muller) was replaced by the Decker Coal Company, reportedly because of turbid water caused by blasting.

Additional nitrogen could be introduced into the ground water by spoil that had been placed in the resaturated zone at the bottom of the pit. Owing to overburden mixing, this spoil could contain material high in soluble ammonia and nitrates. Additional ammonia and nitrates could come from unexploded ammonia-nitrate/fuel-oil explosives. Migration of water through the spoil could carry the nitrogen compounds along reestablished ground water gradients to wells outside the permit area. Ground water wells in mine spoil have occasionally had nitrate concentrations above levels recommended for drinking water (10 mg/l) and even levels approaching those considered unusable for livestock (100 mg/l).

Any wells rendered unusable by mining at the CX Ranch Mine would have to be replaced by Consol. The company proposes to drill all new wells into the Wall coal seam. This seam appears to be capable of producing enough water of premining quality to replace lost wells. During mining, Consol would draw water for drinking, washing, dust control, and fire fighting from three wells tapping the Wall aquifer.

The Squirrel Creek alluvium receives some ground water from overburden and tributary alluvium in the CX Ranch minesite. Observation wells indicate that the amount contributed by the overburden is small (about 25 acre-feet per year). The same is true of tributary alluvial ground water intercepted by the mine. Interception of ground water from these two sources would not appreciably change Squirrel Creek alluvial levels downstream from the mine.

Once mining ceases, ground water upgradient of the mine would enter the mine spoil (replaced overburden). The bottom 200 to 300 feet of spoil would become saturated, reconnecting the coal aquifer cut by the mine pit.

The spoil would increase the concentration of minerals in the ground water. Total dissolved solids (TDS) would increase by roughly 50 percent. Ground water now in the fault-bound block that would contain Consol's pit averages about 1,400 mg/l total dissolved solids. Postmining TDS concentrations would probably rise to an average 2,100 mg/l. Sodium, bicarbonate, and sulfate concentrations would increase the most; other dissolved-constituent concentrations would increase slightly or remain about the same. The water would probably be of the sodium bicarbonate type, similar to premining coal ground water. The amount of sulfate may increase with time (Wayne Van Voast, Montana Bureau of Mines and Geology, oral com., Sept. 1983), especially since the overburden contains fairly high amounts of sulfate. (See Geology, Overburden.)

The overburden at the CX Ranch Mine contains sufficient base-buffering capacity to neutralize any acidic water produced in the spoil. Because heavy metals are generally less mobile in basic environments, spoil water at the CX Ranch would have low heavy-metal concentrations, about the same as before mining (Van Voast, Hedges, and McDermott, 1978a, pp. 45-50).

Spoil ground water would be unsuitable for domestic consumption, but would be acceptable for livestock watering. The high sodium adsorption ratio of the natural bedrock ground water now precludes use of ground water for irrigation and would continue to preclude such use after mining.

The estimated total flow rate through the aquifers proposed for disturbance at the CX Ranch Mine is now about 35 gpm (Keith Thompson, Montana Bureau of Mines and Geology, written com., Nov. 1982). Evaluation of spoil at the West Decker and Big Horn Mines and experiments relating permeability to grain size indicate that CX Ranch mine spoil would not inhibit flow through the minesite. Consol proposes to selectively place the sandy Anderson-Dietz/Canyon interburden at the bottom of the pit. Selective placement of interburden, which has higher transmissivities than the overburden, would enhance ground water movement through the mine spoil.

Ground water from undisturbed coal aquifers upgradient of the mine would pass through spoil to the Anderson/Dietz and Canyon coal aquifers downgradient. Spoil water would move east and northeast toward the West Decker Mine, eventually discharging to the Tongue River Reservoir. (See Surface Water.) The spoil water would flow under the Squirrel Creek alluvial system and would not affect alluvial or surface water quality.

In addition to lowering water levels in nearby wells, the CX Ranch Mine would degrade the water quality of three downgradient wells. One of the wells is unused, another is for stock, and the third is domestic. The one domestic well would probably have to be replaced with a well completed in the Wall coal seam. Increases in TDS caused by the CX Ranch Mine would not affect the usability of the other wells in the area.

The deterioration of water quality in eight other wells (four unused, three domestic, one stock) is possible; however, all lie southeast of a fault with a 100- to 200-foot offset. The fault probably would block spoil water movement in this direction, precluding ground water quality changes in the wells.

SURFACE WATER

Consol proposes a variety of measures to protect surface water flow in Dry Creek and Squirrel Creek. Most important, the flood plain, low terraces, and channel of Squirrel Creek would not be disturbed. In Dry Creek, a reinforced, large-diameter culvert would be constructed under the primary overburden stockpile, nearly eliminating surface water quality and quantity changes in the drainage. In addition, Consol proposes to relocate the upper part of the Powers Brothers Ditch, an irrigation canal. A diversion pipe would be installed to carry the irrigation water around the mine. After reclamation, the ditch would be rebuilt in its original location.

Four ephemeral tributaries to Squirrel Creek and an ephemeral creek draining directly to the Tongue River would be mined through. Runoff from these tributaries would be diverted around the operation, minimizing water losses. Potential recharge lost to Squirrel Creek as a result of mining through the four ephemeral drainages would amount to about 25 acre-feet per year, less than one percent of the combined annual flow of Squirrel Creek and its alluvium.

All five drainages would be replaced in the same general location and configuration. Consol proposes to discharge excess mine water to one of these small drainages emptying into Squirrel Creek. The discharge of 250 to 500 gpm into this ephemeral draw could cause some minor gully erosion. (See Mitigating Measures.)

Eighteen sediment ponds would be built in the 12-year permit area to retain surface runoff from disturbed areas. The ponds would prevent increases in suspended solids from reaching waters outside the minesite. Localized gullying and erosion within the reclaimed landscape after the ponds are removed would not adversely affect Squirrel Creek water quality because the acreages involved are small and the sediment delivery rate out of the basin is low. (See chapter 2, Geology.) A stock pond in the southwest quarter of section 25 would be destroyed, but would be replaced after mining by a sediment pond.

The total acreage disturbed by Consol's proposed 12-year plan would amount to less than 6 percent of the Squirrel Creek drainage area. Temporary storage of storm runoff in the pit and sediment ponds would slightly lower peak flows and lengthen receding flows of Squirrel Creek. Such temporary water retention would not appreciably affect the annual water yields of Squirrel Creek.

Declines in the water table of the Squirrel Creek alluvium during mine year 4 would deplete total average annual runoff in the creek by at most 40 gpm. This depletion would be insignificant: Mean annual stream flow in Squirrel Creek, about 2,200 gpm, is large in comparison. The depletion would occur below the points of water diversion and therefore would not affect irrigation along the creek. Discharge from the mine, normally about 250 to 300 gpm, would more than offset the depletion.

Pit inflow would be pumped into a 500,000-gallon storage pond (about 1 day's inflow). The water would be released to an ephemeral tributary to Squirrel Creek or used to spray roads to suppress dust. Any release would increase the flow in the tributary and in Squirrel Creek.

CX Ranch Mine discharge would lower the concentration of some water quality constituents in Squirrel Creek and raise others. Total dissolved solids (TDS) and sulfate concentrations would remain about the same or be lower than before mining. During low stream flows, for example, concentrations would be one-half to one-fifth premining concentrations (app. D) because the mine discharge water would contain much lower TDS levels than the creek. The sodium adsorption ratio (SAR) of Squirrel Creek water, however, would be much higher, increasing from about 5 to greater than 14 during low flow. For comparison, Consol compiled water quality data gathered by the U.S. Geological Survey for five southeastern Montana streams similar in size to Squirrel Creek. None of these streams had SAR values above 11. SAR values above 14 could severely limit rootzone water availability to plants due to decreased water movement out of the creek and into the soils. (See Soils.) Reduced water availability could kill vegetation next to the creek (see Soils), which in turn could lead to channel instability. The extent of such changes is unknown.

Consol's discharge water would also increase ammonia concentrations in Squirrel Creek. During spring runoff, ammonia concentrations would normally increase by less than 50 percent. During nonpeak flows however, the discharge would more than double average premining concentration (table 3-3). Ammonia levels have historically exceeded the Environmental Protection Agency's (EPA's) ammonia criteria for freshwater aquatic life (U.S. Environmental Protection Agency, 1983) about 15 to 20 percent of the time, and have exceeded the criteria in all seasons of the year. (See chapter 2.) Criteria would be exceeded more often and concentrations would reach higher levels during CX Ranch Mine operation. (See Fisheries.)

TABLE 3-3

Predicted Nitrogen Concentrations in Squirrel Creek During Nonpeak Flows Due to CX Ranch Discharge Water

	Today (mg/l)	During Mining (mg/l)	Percent Increase
Mean nonpeak flow			
Total ammonia, as N	0.3	0.6-1.3	100-330
Nitrate/nitrite, as N	0.2	0.8-2.9	400-1,350
Total soluble inorganic nitrogen, as N	0.6	1.3-4.2	120-600
Extreme conditions[1]			
Total ammonia, as N	1.6	3.2-5.1	100-220
Nitrate/nitrite, as N	1.5	6.2-11.6	310-1,060
Total soluble inorganic nitrogen, as N	3.1	9.4-16.7	200-440

Note: Appendix D, table D-1, is an expanded version of this table with accompanying explanation of variables. A technical support document has been prepared which further explains how the results were calculated. This document is available upon request from the Montana Department of State Lands, Helena.

[1] An extreme combination of circumstances for an extended period.

Nitrate/nitrite concentrations would also rise, but even more dramatically, increasing to more than four times the historical premining average concentrations (table 3-3). Based on water quality data taken from the West Decker and Big Horn mine discharges, the CX Ranch Mine would probably increase Squirrel Creek nitrate concentrations from an average of 0.2 mg/l to over 1 mg/l. (See Aquatic Ecology.) During summer months the concentrations could be even higher, but it is likely that increases could be limited by Consol's plan to use most, if not all, the discharge water for watering haul roads.

The source of the elevated ammonia and nitrate/nitrite concentrations in coal mine discharge water could be one or a combination of several sources: (1) nitrates leached from redistributed mine soils, (2) ammonium-nitrate fertilizers used on reclaimed mine lands, and (3) unexploded ammonium-nitrate/fuel-oil (ANFO) explosives. (See chapter 2.)

Despite these projections of water quality declines, the CX Ranch Mine would not be allowed to discharge to Squirrel Creek any mine water that exceeded ammonia criteria set by the Montana Department of Health and Environmental Sciences under the Montana Pollution Discharge Elimination Discharge permit process (Abe Horpestad, Water Quality Bureau, pers. com., November, 1984). The company could take steps to minimize the amount of ammonia in the discharge water or could discharge directly to the Tongue River, which would be less sensitive to ammonia loading than Squirrel Creek. (See Mitigating Measures.)

Normally, the CX Ranch Mine alone would have a negligible impact on the Tongue River. Average surface and ground water discharge from the mine would amount to less than 1 percent of average river flow. Van Voast and Thompson (1982, pp. 7, 9) calculate that TDS concentrations in the Tongue River water would rise as a result of the CX Ranch Mine by only 5 mg/l, a 1- to 2-percent increase. The river now contains less than 650 mg/l TDS 95 percent of the time, which is safe for irrigation, the primary use downstream. A 1- to 2-percent increase would not be measurable, due to the normal variability in TDS concentrations over time and between samplings sites.

The CX Ranch Mine could increase ammonia and nitrate/nitrite concentrations in the Tongue River as much as 40 percent in extreme circumstances. The increase would be very small under normal conditions. The CX Ranch Mine by itself would not be a major cause of ammonia or nitrate/nitrite problems in the river, but taken together, all future, expanded mining in the upper Tongue River drainage would be significant. (See Cumulative Impacts.)

Construction of the rail loop could slightly increase sediment concentrations of water in Squirrel Creek or the Tongue River adjacent to the mine. Some fill material required for construction of the rail loop would probably end up in Squirrel Creek, temporarily increasing sediment loads at the mouth of the creek. Excessive erosion could be eliminated by proper slope stabilization and revegetation design and construction practices, which the company has not as yet specifically addressed. (See Mitigating Measures.)

ALLUVIAL VALLEY FLOORS

Two hundred ninty-five acres of irrigated hay fields along the downstream reaches of Squirrel Creek were designated by the Department of State Lands as meeting the alluvial valley floors (AVF) criteria and were also determined to provide a significant part of production to the historical farming and ranching operation attached to the fields. Consol's CX Ranch Mine would not affect the quality or quantity of water used for flood irrigating these alluvial valley floor fields because the mine is located below all surface diversions supplying the fields. Although the mine would lower alluvial ground water levels next to the mine, the alluvial water is already too deep for use by vegetation. (See chapter 2.) The mine would not affect the usability or productivity of the alluvial valley floor fields.

The high SAR of the pit water discharge would increase Squirrel Creek SAR values and decrease moisture availability to plants that grow next to the creek. The discharge water would enter Squirrel Creek below the irrigation diversions and therefore would not affect the AVF lands.

LIFE-OF-MINE IMPACTS

Consol's 33-year life-of-mine plan would add 2,200 acres to the mine pit, more than doubling the amount of acreage excavated for coal (fig. 1-2). Within the expanded pit, the coal aquifers would be removed and replaced with spoil. The quality of the ground water in the additional spoil would decline by the same amount as water quality in the initial spoil.

An additional 500 acres, or 1.5 percent, of the Squirrel Creek drainage basin would lie within the expanded disturbance area. The remainder of the life-of-mine area lies in a small basin that drains directly to the Tongue River. The life-of-mine plan would not affect the quantity of Tongue River surface water, since the total minesite would cover only 0.2 percent of the total Tongue River watershed.

The life-of-mine expansion would lower ground water levels as far away as Youngs Creek. Declines in Anderson coal aquifer could draw water into the coal from the Young's Creek alluvium. The amount of water drawn would probably be small, but a more detailed evaluation would have to be initiated as mining approached the Young's Creek drainage. The evaluation would be especially important since portions of Young's Creek may meet the requirements of alluvial valley floor legislation, requiring special hydrologic protection.

Other impacts expected in the proposed plan would be aggravated in the life-of-mine operation. Two additional wells, both located at the townsite of Decker, could undergo measurable water level declines. In addition, a small strip of about 65 to 75 acres of the Squirrel Creek alluvium in sections 24, 25, and 30 would probably be disturbed. Elevated nitrate/nitrite and ammonia concentrations in Squirrel Creek would probably remain high as long as the mine discharges water.

Once the CX Ranch Mine shuts down, nitrate and ammonia increases in Squirrel Creek and the Tongue River would drop. Because mine-spoil water contains nitrate and ammonia concentrations similar to undisturbed coal aquifer ground water, the CX Ranch Mine would not, over the long term, cause nitrogen loading of the Tongue River.

CUMULATIVE IMPACTS

Seven potential and four operating mines lie in the Tongue River Reservoir watershed (figs. IN-2 and 2-1). All eleven, together, could influence the surface water of the Tongue River between Big Horn Mine in Wyoming and the Tongue River Reservoir (Van Voast and Thompson, 1982). Only Consol's CX Ranch Mine and Kiewit Mining and Engineering's Wolf Mountain Mine would influence the surface waters of Squirrel Creek. Five other mines—Ash Creek, Youngs Creek, Wolf Mountain, West Decker, and North Decker—would combine with the CX Ranch Mine in cumulatively influencing ground water (table 3-4). All five lie in the ground water flow path occupied by the CX Ranch Mine.

Ground Water

The northeast-trending faults in the the Decker area appear to act as barriers to ground water flow and, therefore, would confine potentiometric-level declines to coal aquifers located between the faults. Five potential new mines (Ash Creek, Young's Creek, CX Ranch, Wolf Mountain, and North Decker) and one existing mine (West Decker) all lie in the same general ground water flow path (figs. IN-2 and 2-5). Before mining began, flow from the recharge areas along Ash Creek and Youngs Creek moved northeast through each successive minesite, and eventually discharged into the Tongue River Reservoir. The West Decker mine pit now intercepts this ground water, discharging it to the reservoir via several discharge points. Other new mines would also intercept and discharge the water. After all mines closed and the spoil resaturated, ground water would again flow from the original recharge areas to the discharge area along the Tongue River Reservoir. Mine

TABLE 3-4

Cumulative Ground Water Impacts of Mining at the CX Ranch

Mine	Present Disturbed Acreage	Future Disturbed Acres			Wells Destroyed	Other Wells Affected	Stock Ponds Removed	Springs Affected
		Total	Mined	AVF[1]				
CX Ranch								
Permit (12-year)	0	1,905	429	14.1	3	6	1	0
Life-of-mine	0	3,720	2,600	50-60	4	6	3	0
Wolf Mountain	0	1,947	1,470	5.2	4	2	1	0
West Decker	1,340	3,565	2,474	0	1	8	2	0
North Decker	0	2,870	2,303	160	5	3	1	3

[1] Alluvial valley floor.

spoil would not inhibit continued recharge and ground water movement, since the coal and spoil aquifers have similar hydraulic characteristics.

A number of wells near mine pits would be affected by mining at the CX Ranch, Wolf Mountain, West Decker, and North Decker mines. Ten wells would be removed by excavation (app. D, table D-2). Water levels would decline in 17 other wells (app. D, table D-3), either lowering or eliminating water yields. Only one private well (not owned by coal companies) would be lost. Water levels in two other private wells could decline as much as 20 to 40 feet, probably not enough to make them unusable. However, pumping costs would increase. For example, running a pump continuously for a well with water standing 150 feet below the surface would cost about $6.00 a month more if the water level declined 30 feet.

Wells now tapping coal beds below the Dietz 2 coal seam would not be significantly affected by mining. The part of the Canyon coal aquifer close to the CX Ranch Mine would undergo substantial water-level declines; however, the only two wells that now tap the Canyon aquifer also tap the underlying Wall seam and therefore the wells would remain usable.

Along with wells, three springs near the North Decker Mine would be affected: One (T8S, R40E, section 33, NW¼ SE¼ NW¼ SW¼) would be excavated; two others (T9S, R40E, sections 3, NW¼ NW¼ NE¼ SE¼ and 11, SE¼ NW¼ NW¼ NW¼) would stop flowing when the mine pit intercepts their water. Springs southwest of the West Decker Mine would not be affected. No springs lie near the CX Ranch and Wolf Mountain Mines. (See table 3-4).

The elimination of wells, springs, and ponds would not adversely affect postmining land uses. Most water sources would be replaced with wells tapping either shallow alluvium or aquifers below the strata excavated during mining. Consol proposes to complete replacement wells in the Wall coal seam. At least one of the sedimentation ponds used to capture sediment from reclaimed mine lands would be left as a permanent impoundment.

The quality of water after mining in the Decker area can be predicted based on analyses of saturated overburden paste extracts. Data are available from the CX Ranch, Wolf Mountain, and West Decker minesites for calcium, magnesium, and sodium concentrations. (Note: In making predictions, it is assumed that the ratio of sulfate to bicarbonate in water leaving each mine would be similar to today's average sulfate-bicarbonate ratio in West Decker Mine spoil.) Predictions show that the impacts on ground water quality would probably be cumulative. That is, ground water quality would steadily worsen as the water passes through more and more spoil (table 3-5).

In the Squirrel Creek area, the process would start at the CX Ranch Mine. From there, water would flow through the proposed Wolf Mountain Mine, into the West Decker Mine, and possibly into the North Decker Mine. Flow along the entire path would take thousands of years. (Note: Changes could actually start at the Ash Creek and Youngs/Tanner Creek mines, but these changes were not included in calculations because the affected ground water would take tens of thousands of years to reach the CX Ranch Mine. By that time, CX Ranch Mine spoil water quality would have begun to improve.)

Despite poorer quality, ground water from shallow wells completed after mining would remain usable for livestock watering. Water in spoil and unmined Anderson/Dietz coal downgradient from mine areas would be tolerable for cattle (recommended TDS limit: 6,400 mg/l) and horses (recommended TDS limit: 7,100 mg/l). Livestock may have to drink more water to compensate for the increase in TDS concentrations above premining levels. On the other hand, the stock may reduce water uptake, resulting in some weight loss (Natural Academy of Sciences, 1974, p. 41). However, deeper aquifers normally containing better water could be used. Sulfate, dissolved solids, and possibly nitrate content would make the spoil water unsuitable for human consumption.

Surface Water

Squirrel Creek. Both the CX Ranch and Wolf Mountain Mines would discharge mine pit water into Squirrel Creek. Maximum pit pumpage from the CX Ranch Mine would reach 500 gpm and from the Wolf Mountain Mine 1,300 gpm. Combined, these pit discharges represent only about 10 percent of the creek's estimated average discharge capacity, not enough to appreciably change stream flow or channel characteristics.

TABLE 3-5

Cumulative Ground Water Quality Changes As Ground Water Passes Through Successive Mine Areas

	Existing Ground Water[1]	CX Ranch Mine Spoil[2]	Wolf Mountain Mine Spoil[2]	West Decker Mine Spoil[2]
TDS	1,260	2,100	3,050	4,200
Calcium	5	30	40	50
Magnesium	5	15	20	20
Sodium	500	800	1,100	1,450
Bicarbonate	1,360	1,750	2,000	2,000
Sulfate	10	380	400	1,670

Note: These predictions disregard the probability that some soluble salts in spoil would be removed before the arrival of ground water from upgradient mines. Leaching experiments suggest that ground water quality downgradient from the CX Ranch and Wolf Mountain Mines might not be as poor as outlined above, but what difference preleaching would make is uncertain.

[1] Average of four domestic wells (Decker Store, Montana Club, Jim Muller, and CX Ranch) and two observation wells (WCX-19 and WR-51) completed in the Anderson/Dietz coal seam.

[2] Source: Keith Thompson and Wayne Van Voast, Montana Bureau of Mines and Geology, written com., Nov. 1982.

Water quality, however, would decline. During mining, under extreme circumstances, TDS concentrations in Squirrel Creek would reach a peak of about 2,660 mg/l, an increase of 183 percent. The greatest increase would occur during low flow. (This prediction relies on water quality analyses from the U.S. Geological Survey's gaging station located upstream of the mine.) TDS concentrations in Squirrel Creek next to the mine would be influenced less, reaching about 4,830 mg/l, a 40-percent increase above today's levels. Other dissolved constituents of TDS would increase similarly.

The increases in total dissolved solids would stem entirely from the Wolf Mountain Mine's discharge, owing to the much greater quantity of alluvial ground water high in TDS flowing into the Wolf Mountain Mine pit. During most years, under most flow conditions, mine pit water discharges would raise TDS concentration much less than predicted for extreme circumstances. Moreover, pit water would discharge below the irrigation diversion ditches on Squirrel Creek. Therefore, despite the increase in TDS concentrations in the lower reaches of Squirrel Creek, irrigated lands would be unaffected.

If the Wolf Mountain Mine and CX Ranch Mine operate together, the two would more than double nitrate, ammonia, and total soluble inorganic nitrogen concentrations in nonpeak flow (table 3-6). This assumes pit discharge water from both mines contains nitrogen compound concentrations similar to those in the discharge of the East and West Decker and Big Horn mines. The frequency and duration of ammonia concentrations exceeding EPA criteria for freshwater aquatic life would increase appreciably as a result of the two mine discharges. (See Fisheries and Aquatic Ecology.)

TABLE 3-6

Predicted Nitrogen Concentrations in Squirrel Creek If CX Ranch and Wolf Mountain Mines Simultaneously Discharged Pit Inflow Water During Nonpeak Flow Periods

	Historic Conditions (Mean) mg/l	With Mine Discharges mg/l	Percent Increase
Mean conditions			
Total ammonia, as N	0.3	0.6-1.4	100-250
Nitrate, as N	0.2	1.2-3.2	500-1,500
Total soluble inorganic nitrogen, as N	0.5	1.8-4.6	260-820
Extreme conditions[1]			
Total ammonia, as N	1.6	2.4-3.4	70-110
Nitrate, as N	1.5	3.0-4.8	130-230
Total soluble inorganic nitrogen, as N	3.1	5.4-8.2	125-160

Note: Appendix D, table D-4, is an expanded version of this table with accompanying explanation of variables. A technical support document has been prepared which further explains how the results were calculated. This document is available upon request from the Montana Department of State Lands, Helena.

[1] An extreme combination of circumstances for an extended period.

TABLE 3-7

Predicted Nitrogen Concentrations At the Upstream End of the Tongue River Reservoir

	Historic Conditions (mg/l)	With 11 Mines (mg/l)	Percent Percent Increase
Predominant conditions			
Total ammonia, as N	0.1	0.14	40
Nitrates, as N	0.1	0.18	80
Total soluble inorganic nitrogen, as N	0.2	0.32	60
Extreme conditions[1]			
Ammonia, as N	0.3	0.7	140
Nitrates, as N	0.4	1.0	150
Total soluble inorganic nitrogen, as N	0.7	1.7	145

Note: Appendix D, table D-5, has footnotes and subscripts that explain the values used in calculating the figures in this table. A technical support document has been prepared which further explains how the results were calculated. This document is available upon request from the Montana Department of State Lands, Helena.

[1] An extreme combination of circumstances for an extended period.

Tongue River. The major surface water quality impacts on the Tongue River from all 11 mines (4 operating and 7 possible) above the Tongue River Reservoir would be increases in both TDS and nitrogen concentrations. Van Voast and Thompson (1982) concluded that with expanded mining above the Tongue River Reservoir, total dissolved solids in the river would be increased by more than 30 mg/l about half the time and by 50 mg/l 10 percent of the time. Because dissolved solids would rarely exceed 600 mg/l even with mining, the small changes caused by mining would not change the usability of Tongue River water for stock watering or irrigation.

Increases in nitrogen compounds (ammonia and nitrate/nitrite) would be more noticable. On the average, ammonia concentrations would remain low, increasing by less than 30 percent. In extreme circumstances, however, ammonia could more than double at the upper end of the reservoir. The same general trend is true for nitrate/nitrite concentrations (table 3-7). The frequency and length of time that ammonia concentrations exceed EPA criteria for fresh water aquatic life (U.S. Environmental Protection Agency, 1983) would increase slightly. (See Fisheries.) The EPA criteria *would be exceeded more often* than if no mining were to take place, *but not as often as occurred* in the Tongue River *before* the Sheridan treatment plant was upgraded. (See chapter 2, Surface Water, Tongue River.) The increase in total soluble inorganic nitrogen (ammonia plus nitrate/nitrite) may affect the algae composition of the Tongue River Reservoir. (See Aquatic Ecology.) Changes in nitrogen concentrations in the river would normally not affect the usability of the water for livestock watering or irrigation, the primary consumptive uses downstream.

Once the mines stop discharging water, they would no longer add to the ammonia or nitrate load of the river; spoil water nitrate and ammonia concentrations are similar to nearby ground water and flow rates would drop back to premining rates.

Continued population increases in the Sheridan area related to mining could also cause increased ammonia and nitrate/nitrite concentration in the river. These increases would result from more sewage discharge by Sheridan and septic tanks. The amount of such increases is difficult to predict.

Alluvial Valley Floors

A maximum of 25 acres (less than 10 percent) of the alluvial valley floor (AVF) on Squirrel Creek would be disturbed by CX Ranch and Wolf Mountain life-of-mine operations—mainly roads and stockpiles. Covering nonirrigated AVF pasture land with roads and stockpiles would not affect surface or alluvial ground water quality or quantity. Overall production from AVF lands would not be reduced significantly.

Together, the CX Ranch and Wolf Mountain operations would mine through eight ephemeral tributaries to Squirrel Creek. Assuming that all eight are disturbed at once, about 30 gpm of surface water recharge would be lost to Squirrel Creek. Compared to the estimated average annual flow in the creek of 2,200 gpm, this loss would be insignificant.

Only the Ash Creek Mine and the CX Ranch Mine's life-of-mine extension could lower alluvial ground water levels in Youngs Creek valley floor. Under extreme circumstances, the amount of water withdrawn from the alluvium could reach as much as 130 gpm from years 2002 to 2011, although the actual withdrawal would probably be much lower. The loss of alluvial ground water in the Young's Creek alluvium could affect subirrigated areas next to and downstream of the alluvial drawdown area.

MITIGATING MEASURES

- Ammonia and nitrates could be removed from the mine discharge water. Many different systems have been devised to remove ammonia and nitrates from municipal sewage. Such a system could be adopted for treating mine discharge water. One possible solution would be to add a carbon source (sugar) to the mine water in a holding reservoir, allowing bacteria to fix ammonia and nitrates. The bacteria, upon dying, would settle out on the bottom of the ponds and in turn remove the nitrogen compounds from the system. Large settling ponds would be necessary and would have to be periodically drained to remove the accumulated sludge. The sludge could be disposed of in a landfill.
- Another approach could be to discharge the mine water directly to the Tongue River, thereby avoiding Squirrel Creek. The Tongue River has much higher flows and normally has fairly low ammonia levels now that the Sheridan Treatment Plant has been upgraded. As a result, discharging CX Ranch inflow directly to the river would be possible. The Department of Health and Environmental Sciences would probably set a limit on the amount of ammonia that could be discharged to the river, thereby protecting aquatic life.
- During summer months, when the mine discharge water would greatly increase the sodium adsorption ratio of Squirrel Creek, calcium or magnesium salts could be added to the water to decrease the SAR value.
- A specifically designed treatment lagoon or the total elimination of mine discharges to Squirrel Creek (e.g., watering haul roads) are two possible solutions to both ammonia/nitrate and the SAR problems. The type of pollution control system that is best suited for the CX Ranch discharge would have to be determined based on detailed economic and engineering findings.
- Riprap (boulders) placed in the small ephemeral draw into which Consol proposes to discharge mine water could prevent initiation of channel incision and minor erosion. Jute netting or straw mulch placed on the steep railroad fill slopes could help to minimize erosion prior to revegetation.

SOILS

Summary of Impacts: Consol would salvage enough good quality soil for successful overall plant growth after reclamation. Prolonged soil storage, however, would biologically degrade the soil, and this could lower postmining vegetative vigor and diversity for an unknown period of time. Unavoidable soil impacts would include loss of the natural soil profile and pore space continuity, an overall reduction in pore space, a breakdown of soil structure, and a reduction in organic matter concentration. During mining, increased sodium levels in Squirrel Creek could adversely affect soils and vegetation next to the creek.

SOIL QUANTITY AND QUALITY

Salvageable Soil

Consol is proposing to salvage about 2,200 acre-feet of good quality soil. After mining, this would yield an average cover of about 26 inches—4.5 inches of topsoil and 21.5 inches of subsoil (table 3-8). Excess sodium,

TABLE 3-8

Soil Resources of the Proposed Disturbance Area

				Proposed Total Salvageable	Estimated Salvage Volumes (Acre-Feet)				
Footnotes	Soil Mapping Unit	Acres to be Disturbed	% of Total Area to be Disturbed	Depth, Inches (topsoil/ subsoil)	Primary Lift (topsoil)	Secondary Lift (subsoil)	Total	% of Total Salvageable Volume	Primary Limiting Factors
g	Arvada soils, 0-2%	1.9	0.2	6/0	0.95	0.00	0.95	0.1	Excess clay
a	Bolcar CL. 2-6%	24.2	2.7	6/78	12.10	157.30	169.40	9.5	Sodium, soluble salts
a.b.g	Bolcar-Hysham CLs, 2-6%	6.2	0.7	6/36	3.10	18.60	21.70	1.2	Sodium, soluble salts
a	Colbar SiCL, 0-4%	104.0	11.6	6/30	52.00	260.00	312.00	17.4	Sodium pH, excess clay
a	Corkim L. 4-8%	44.1	4.9	6/42	22.05	154.35	176.40	9.8	Sodium, soluble salts
	Dwyer & Yewder LFSs, rolling	7.3	0.8	6/0	3.65	0.00	3.65	0.2	Excess sand
	Haverson soils. variant	1.5	0.2	6/30	0.75	3.75	4.50	0.3	Sodium, soluble salts
a	Heldt SiCL. 0-2%	9.9	1.1	6/12	4.95	9.90	14.85	0.8	Sodium, soluble salts, excess clay
a	Ingar SiCL	27.2	3.0	6/54	13.60	122.40	136.00	7.6	Sodium, soluble salts
a	Kim & Lomar CLs. 2-6%	87.3	9.7	6/42	43.65	305.55	349.20	19.5	Sodium, pH, soluble salts
a	Kim & Lomar CLs. terrace edges	8.8	1.0	6/42	4.40	30.80	35.20	2.0	Sodium, pH, soluble salts
a.i	Kim & Lomar-Shingle CLs, 4-10%	51.8	5.8	6/36	25.90	155.40	181.30	10.1	Sodium, pH, soluble salts
a.i	Kim & Lomar-Shingle CLs. dissected. 4-10%	7.3	0.8	6/36	3.65	21.90	25.55	1.4	Sodium, pH, soluble salts
a.b.g	Kim & Lomar-Hysham CLs. 2-6%	28.0	3.1	6/18	14.00	42.00	56.00	3.1	Sodium, pH, soluble salts
	Lenoy-Eltass FSLs. undulating	13.5	1.5	6/24	6.75	27.00	33.75	1.9	Excess sand
a.c	McRae L. 1-4%	9.1	1.0	12/36	9.10	27.30	36.40	2.0	Sodium, soluble salts. excess clay
e	Nelson-Tassel SLs undulating	24.9	2.8	6/0	12.45	3.74[e]	16.19	0.9	Excess sand
a	Prell SiL. 2-5%	4.3	0.5	6/60	2.15	21.50	23.65	1.3	Soluble salts
	Remm SL. 5-10%	8.4	0.9	6/66	4.20	46.20	50.40	2.8	Excess sand, sodium
h	Rentsac & Wibaux CNLs. rolling	20.0	2.2	0/0	0.00	0.00	0.00	0.0	Excess rock fragments[h]
	Shingle soils, rolling	38.0	4.2	6/0	19.00	0.00	19.00	1.1	Shale
	Shingle soils. hilly	58.4	6.5	6/0	29.20	0.00	29.20	1.6	Shale
d.h	Shingle soils-rock outcrop. very steep	159.3	17.7	0/0	0.00	0.00	0.00	0.0	Slope steepness, rock outcrops
d.h	Shingle soils-shale outcrop, very steep	21.3	2.4	0/0	0.00	0.00	0.00	0.0	Slope steepness, shale outcrops
h	Shingle-Tassel soils, rolling	12.8	1.4	6/0	6.40	0.00	6.40	0.3	Shale, sandstone, soluble salts, excess sand
f.h.i	Shingle-Rentsac soils, rolling	18.1	2.0	6/0	9.05	0.00	9.05	0.5	Shale, excess coarse fragments
f.h.i	Shingle-Rentsac soils, hilly	31.5	3.5	6/0	15.75	0.00	15.75	0.9	Shale, excess coarse fragments
f.h.i	Shale Outcrop-Shingle Soils, very steep	8.9	1.0	0/0	0.00	0.00	0.00	0.0	Shale, excess coarse fragments, slope steepness
a.c	Thurlow SiCL. 0-2%	6.3	0.7	12/36	6.30	18.90	25.20	1.4	Sodium, excess clay
a	Ultex SiCL, saline	0.4	<0.1	6/30	0.20	1.00	1.20	0.1	High water table, soluble salts
a	Ultex SiCL, wet	0.4	<0.1	6/18	0.20	0.60	0.80	<0.1	High water table, soluble salts
	Wolruth SiCL. level	9.4	1.0	6/42	4.70	32.90	37.60	2.1	Soluble salts, sodium excess clay
	Shale outcrop	18.4	2.0	0/0	0.00	0.00	0.00	0.0	No soil
	Shale & Rockland	3.4	0.4	0/0	0.00	0.00	0.00	0.0	No soil
	Scoria pit	0.8	0.1	0/0	0.00	0.00	0.00	0.0	No soil
	Sediment Control Structures	22.1	2.5						Seefootnote j
	TOTALS	899.2	100.0		330.20	1.461.09	1,791.29	100.0	

Source: Consolidation Coal Company, 1984, vol. 4.

Note: Table does not include soils within the proposed 12-year permit area that would not be disturbed by mining or associated activities. Soil names are not official; they are used for reference only. CL = clay loam; L = Loam; FSL = fine sandy loam; LFS = loamy fine sand; SiC = silty clay; SiCL = silty clay loam; SL = sandy loam; SiL = silt loam; CNL = channery loam. Percentage figures following mapping unit names represent slope ranges where unit is found.

[a] Unit would be sampled prior to salvage.

[b] Hysham component would not be salvaged.

[c] Soil meets prime farmland criteria in railroad loop area. Soil would be salvaged to a total depth of 48 inches in the loop area. Outside of the loop area, the McRae and Thurlow soils would each be salvaged to a total depth of 66 inches. (These soils only cover a total of 1.33 acres outside of the loop.)

[d] Accessible soils in this unit would be salvaged for a 6-inch primary lift.

[e] Tassel component would also have a 6-inch secondary lift salvaged.

[f] The Rentsac component would only be salvaged for 6 inches of primary lift, and only if coarse fragment content of upper 6 inches is less that 35 percent.

[g] Bare areas would not be salvaged.

[h] Soil could be used in tree and shrub planting areas.

[i] Shingle component would only be salvaged to 6 inches as primary lift material.

[j] The sediment control structures consist of narrow ditches and ponds of varying size that would occur throughout many of the soil types. Soils in these areas would be bladed to the side and temporarily revegetated for erosion control. During final reclamation, the soils would be bladed back into place and permanently revegetated.

soluble salts, clay, and coarse fragments are the major limiting factors that would prevent deeper salvage. That is, deeper salvage would degrade postmining soil quality.

The proposed salvage depths and volumes (table 3-8) are based on the soil chemical and physical properties given in the company's permit application. The actual volumes could vary. Consol would, in every case, maximize soil salvage. Before mining, a soils technician would examine and stake the soil. The stakes, showing depths of good quality soil, would guide the scraper operators during soil stripping. The technician would also sample and analyze soils whose quality is questioned by the Department of State Lands. The analyses would be given to the Department and, if necessary, salvage depths would be adjusted.

At 26 inches, overall average soil depth would be sufficient to provide for maximum potential productivity of vegetation. Plant productivity at other mines in Montana, Wyoming, and North Dakota has increased as soil depth was increased up to about 24 inches. Deepening the soils further did not add any apparent biomass (Barth and Martin, 1982; Colorado School of Mines Research Institute, 1980). Plant productivity at the CX Ranch is expected to follow similar trends.

Consol's overburden handling and testing plan would ensure that most spoil replaced beneath the respread soil would be nonsodic and favorable overall. (See Geology, Overburden.) The suitable spoil would thus act as favorable subsoil, deepening the 26 inches of overall favorable soil material by about 6 feet.

Nonsalvage Areas

The primary overburden stockpile would be located in two areas where some slopes are in excess of 18 degrees (33 percent) (fig. 3-2). One of the steep-slope areas lies to the west and the other to the north of the stockpile. The steep slope area to the north actually comprises mostly cliffs; therefore, little or no soil exists today, and no salvage would take place during the mining operation.

At present, the soils on the slopes to the west are relatively stable, held by vegetation and the armoring from sandstone and shale fragments. Since little soil covers these slopes, and the steep and rough topography would limit salvage, no salvage would take place. Instead, Consol would preserve the existing soils in place.

Consol proposes to apply 6 tons of straw per acre or install jute netting to mark the contact between the steep slope soil and spoil. During spoil removal, the equipment operator could identify the soil surface by watching for this marker. The soil, as well as the rock outcrops, would be retained somewhat intact. The armoring from the sandstone and shale fragments, which now helps maintain slope stability, would also be retained. Following spoil removal, Consol would test the soil to determine if any sodium had leached from the spoil into the original surface soils. If elevated sodium levels were found, soils would be treated with gypsum to alleviate potential revegetation problems.

STEEP SLOPE RECLAMATION

Consol proposes to take special steps to revegetate the two steep slope areas. The company would seed the slopes with a mixture of big sagebrush, grasses, and forbs. (See app. C.) An annual nurse crop, such as wintergraze, would be seeded concurrently with the permanent soil mixture for erosion control. This would be followed by hand planting of containerized trees and shrubs at a rate based on 100 percent of each species' present density.

Consol would reclaim the slopes from top to bottom as the spoil is removed. Once exposed, the slopes would immediately receive nitrogen and phosphorus fertilizers with a low salt index. Seed would be applied either with a hand-broadcaster or a steep slope scarifier-seeder, an implement operated from a hydraulic crane attached to a truck. The truck would ride over the receding spoil surface, moving the scarifier-seeder along the contour of the slopes. The scarifier-seeder, used on slopes of up to 75 degrees (Larson, 1980, p. 111), should operate effectively on Consol's steep slopes, which are slightly greater than 18 degrees.

The company's steep slope plan, as proposed, appears workable and adequate, although mulch rates for initial erosion control could be improved. After fertilization and initial scarification and seeding, Consol proposes to apply *either* 1 or 2 tons of native hay per acre *or* 250 pounds of wood fiber hydromulch per acre. A tackifier (chemical used to hold fiber or hay in place) would also be applied at a rate of 80 pounds per acre.

According to research summarized and discussed by Kay (1978a and 1978b), Consol would improve its initial plant establishment and erosion control by committing to the native hay application (at a rate of at least 1 1/2 to 2 tons per acre) with a tackifier, or by increasing the wood fiber application at least fourfold (also using a tackifier). Native hay could be blown onto the slopes with a straw blower and the tackifier could be sprayed over the hay. This method has the advantages of being more cost-effective than wood fiber mulch and being more effective in controlling initial erosion and aiding plant establishment (Kay, 1978a and 1978b).

The annual nurse crop and mulch and tackifier application, along with the armoring effect of the slope's rock fragments, would prevent excessive erosion until the vegetation becomes established. Vegetation establishment would be hastened by the northeast aspect of these slopes, since available moisture would be greater than on slopes of most other aspects.

Some steep slope gully erosion can be expected. Consol would monitor the revegetated slopes for gul-

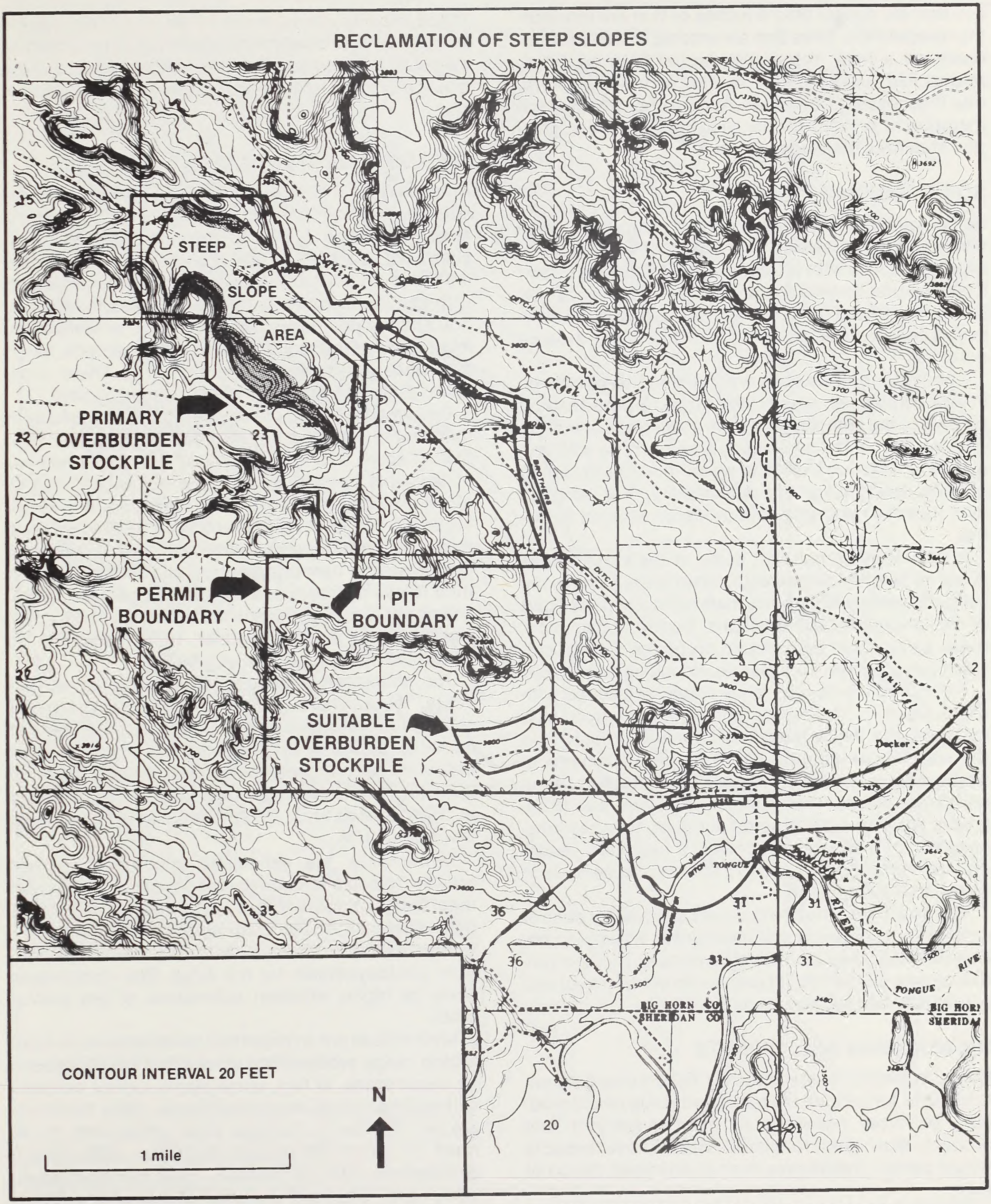


FIGURE 3-2 During mining, Consol proposes to cover two steep slopes with the primary overburden stockpile. Successful reclamation of the slopes requires a special reclamation plan.

lies that are deeper than 9 inches or that are threatening revegetation. Sites that are eroding would be delineated on a map; the gullies would then be tilled, retopsoiled, and seeded at the first seasonal opportunity. If necessary, Consol would use other stabilization methods to prevent further gullying until the vegetation stabilizes the slopes.

SOIL EROSION POTENTIAL

Soil erosion on other parts of the reclaimed minesite would not be excessive. The degree of erosion, however, would vary with different soils. According to Soil Conservation Service soil erodibility factors, most CX Ranch soils have a moderate erosion potential. However, a considerable amount of soil has a high erosion potential.

The highly erosive soils are found in two places: (1) in soil complexes, where they make up less than 50 percent of the complex; and (2) in small areas of limited acreage. In the limited-acreage areas, mixing with surrounding, less erosive soils would take place during salvage, stockpiling, and replacement. The resulting mixture would probably have moderate erosion potential.

In the larger complexes, some of the erosive soils could be handled separately. Consol plans to store the surface layers of the erosive material in a separate part of the primary topsoil stockpile. During reclamation, these soils would be replaced on gentle slopes, outside drainageways. This plan would minimize erosion.

Most of the reclaimed lands would be seeded with wintergraze, a temporary annual cover crop, and mulched with native range hay crimped vertically into the soil. Slopes gentler than 8 degrees (14 percent) would receive 2,000 to 3,000 pounds of mulch per acre, and slopes steeper than 8 degrees (but less than 18 degrees), 3,000 to 4,000 pounds per acre. On sites inaccessible to mulching equipment, a hydraulic seeder mulcher would apply 2,000 to 3,000 pounds per acre of forest fiber hydromulch.

The cover crop mulching would adequately control erosion in most areas until permanent vegetation becomes established. As with steep slopes, if rills or gullies appear, Consol would prepare an erosion map and a timetable and method for repair.

UNAVOIDABLE SOIL IMPACTS

Some impacts on soils at the CX Ranch would be unavoidable. As a result, the reclaimed lands would probably be more sensitive to mismanagement and drought than prior to disturbance. These impacts would correct themselves over an unknown period of time.

The unavoidable impacts, typical of all strip-mining operations, include a decrease in infiltration and percolation rates, which in turn may increase erosion. These impacts are the result of the loss of the natural soil profile and pore space continuity, a reduction in overall pore space, a breakdown of soil structure, and a dilution of organic matter from mixing with mineral soil.

PROLONGED SOIL STORAGE

An additional impact at the CX Ranch Mine would be soil deterioration from prolonged storage. This would arise from Consol's plan to store most soil in stockpiles until year 8. From year 8 on, the company would reclaim both with soil that has been stockpiled and with soil hauled directly from newly disturbed areas. Soil storage decreases the quantity of, or eliminates, important soil microorganisms such as bacteria, fungi, and algae (Miller and Cameron, 1976). These organisms play essential roles in soil nutrient cycling.

Reclamation would initially be most successful with the freshly stripped soil. Spread immediately over graded spoil, freshly stripped soil contains a number of favorable components. One is the seed of native plants (Beauchamp et al., 1975; Howard and Samuel, 1979; Schafer, 1979; Iverson and Wali, 1982). Another is rhizomes (underground stems) and other plant parts that grow after transport (Howard and Samuel, 1979). A third is soil microorganisms, such as bacteria, fungi, and algae. Although the soil also contains some undesirable weedy species (Hodder, 1977), these can be controlled by management techniques.

The stockpiled soil loses these favorable components. Researchers generally agree that the major changes in disturbed and stockpiled soil are shifts in dominant soil fungi and the reduction or loss of other important microorganisms, such as mycorrhizal fungi (Fresquez and Lindemann, 1982; Liberta, 1981; Rives et al., 1980; Reeves et al., 1979; Miller and Cameron, 1976; Davidson, 1976).

Mycorrhizae are especially important to plant growth. They are structures that develop when certain fungi and plant roots form a symbiotic (mutually beneficial) relationship. The fungi absorb nutrients and water for the plants. The plants provide carbohydrates from photosynthesis for the fungi. The mycorrhizae serve as highly efficient extensions of the plants' roots.

Mycorrhizae are an important consideration in maximizing range productivity, since most plants depend on mycorrhizae. In fact, some plants cannot succeed without their fungal associate (Trappe, 1981). Mycorrhizae are reported to increase plant productivity by as much as 400 to 500 percent (Davidson, 1976; Mosse and Hayman, 1971; Gerdemann, 1970). Mycorrhizae are particularly important to plants' phosphorus nutrition and water uptake (Christensen and Allen, 1980). Thus, the association of mycorrhizae with plants in southeastern Montana is especially critical because of the semiarid climate and naturally low plant-available phosphorus levels in soils and overburden (Muir, 1971; Power et al., 1978).

At the CX Ranch, significant changes would probably take place when soil is disturbed and stored for prolonged periods. As the severity of the disturbance increases (e.g. prolonged soil storage), so does the potential for elimination of these fungi and, therefore, an increase in the time required for reestablishment of vegetation dependent on mycorrhizal associations (Reeves et al., 1979). The loss could lower plant species diversity and vigor for an unknown time. Eventually, mycorrhizae would invade reclaimed soils, but the time necessary for this to occur is unknown.

No feasible field method of artificially establishing the mycorrhizal relationship exists. When possible, Consol would use tree and shrub stock inoculated with mycorrhizal fungi in a nursery. However, no method is available for inoculation of grass and forb species, which would be planted as seed in the field. It must first be determined if such applications are biologically feasible. If they are, specific strains of fungi must be identified and selected as being compatible with the plants to be grown. Researchers must then develop a method of inoculation—for example, with spores or pure cultures diluted with soil (D. Marx, USDA Forestry Sciences Lab., Athens, Georgia and A.E. Harvey, USDA Forestry Sciences Lab., Moscow, Idaho, oral communs., June 13, 1983).

Because the CX Ranch Mine would be a new mine, direct-hauling soil from new disturbance areas to regraded reclamation areas is not possible until several years after mining begins. However, the company should develop and propose some technique for sustaining microorganism populations in storage piles. (See Mitigating Measures.)

PRIME FARMLAND SOILS

About 14 acres of soils under the proposed rail loop (fig. 2-7) meet the criteria for prime farmland soils. Impacts on these soils would be solely associated with the construction and use of the rail loop; no overburden or coal would be removed.

The prime farmland soils would be salvaged in two lifts to a depth of 48 inches. Soils below that depth would not be directly affected by construction. The fill used during construction would be analyzed chemically and physically prior to placement at the site. This analysis would ensure that the fill material would not contaminate the subsoils. Prime farmland soils would be stored separately from other stockpiled soils.

Reclamation of the prime farmland area would not begin until at least 13 years and as much as 33 years after initial disturbance. Meanwhile, stockpiled soil would deteriorate. During reclamation, Consol would take steps to biologically restore the soil by adding 10 tons of manure per acre and by using methods available at that time that would reestablish soil microorganism populations.

Restoring the soil as Consol proposes has two problems: Although the manure would supply some important soil microorganisms and act as an energy source for those species, it probably would not supply all the important soil microorganisms, especially mycorrhizal fungi. Second, although reinfecting disturbed areas with soil microorganisms would reduce biological soil impacts, no inoculation method would necessarily be available at the time of reclamation. (See Mitigating Measures.)

IMPACTS OUTSIDE THE PERMIT AREA

The projected increase in sodium in Squirrel Creek during mining could have an adverse effect on the soils and vegetation next to the creek. Squirrel Creek today has a sodium adsorption ratio value (SAR—a measure of sodicity) of about 1 during normal flow and about 5 during low flow (three to four months per year). During mining, SAR values are expected to reach about 5 during normal flow and 14 or greater during low flow. (See Hydrology.) Creek water mixes with the alluvial ground water for an unknown distance next to the creek. To the extent that this occurs during mining, the sodium may accumulate in the rootzone and possibly migrate to the soil surface. This would decrease vegetative productivity and vigor, and, in some places, cause vegetation to die.

It is possible that the increased sodium could eventually seal off the creek channel. The seal could prevent the surface water from mixing with the alluvial ground water. Depending on how quickly and to what extent the seal develops, impacts on soils and vegetation could be decreased.

After mining, natural processes such as leaching and lateral flow would remove the sodium from the soils. Removal would take several times longer than accumulation, owing to a decrease in the rates of infiltration and flow in the soils and alluvium. Consol should take steps to assure that higher quality water is discharged into Squirrel Creek. (See Hydrology, Mitigating Measures.)

MITIGATING MEASURES

- Consol could improve its initial plant establishment and erosion control on the steep slopes by use of native hay mulch applied at a rate of at least 1½ to 2 tons per acre, anchored with a tackifier. If wood fiber mulch (with a tackifier) is used in place of hay mulch, Consol would attain better results by increasing the fiber application rate at least fourfold.

- Consol could partly compensate for the loss of microorganisms, such as mycorrhizal fungi, by spreading out the topsoil (A and upper B horizons) stockpiles to increase their surface area. This would help maintain soil quality in both the main stockpiles and the prime farmland piles.
- The reason for spreading the piles is that only in the upper few feet or so of any stockpile can organisms such as mycorrhizal fungi function, since they require oxygen and a host plant. A number of expanded piles would sustain more soil microorganisms, assuming the surface area is increased and the stockpiles are planted with native vegetation. A greater opportunity would therefore exist for mycorrhizal fungi to survive. If more organisms survive in the stockpiles, more organisms would be available in the soils to infect other plants during revegetation.

The plan to spread the stockpiles may require an adjusted or enlarged permit area. Since Consol holds the surface rights next to the permit area, an adjustment or expansion should be possible. A strategy to reduce soil degradation from prolonged storage would increase the quality of soils available during reclamation. This, in turn, would improve the chances of initial revegetation success, as well as increase plant diversity.

VEGETATION

Summary of Impacts: Biological impacts on soils due to prolonged storage could lower postmining vegetative diversity and vigor for an unknown time period following reclamation. During mining, increased sodium levels in Squirrel Creek could adversely affect vegetation growing next to the creek.

REVEGETATION

Consol's reclamation and revegetation plan would return adequate vegetative cover to the mined, backfilled, regraded, and retopsoiled lands. However, the company may not achieve premining species diversity for many years following initial revegetation. In addition, some species that are planted may not grow as well as they would in undisturbed soils. The lower diversity and vigor, in part, would stem from biological impacts on soils due to prolonged storage. (See Soils.)

The loss of important soil microorganisms could inhibit some native plants, which depend on these microorganisms, from initially growing on the reclaimed lands. Although the important microorganisms and plants would eventually reestablish themselves, this may take many years.

No known method exists for large-scale inoculation of all important soil microorganisms. Therefore, Consol should propose a method of sustaining the existing microorganism populations in the stockpiles. (See Mitigating Measures.)

Topsoil is a source of seed for many native plants. Some of these seeds are not available commercially. Prolonged soil storage causes much of the seed to lose its viability and therefore contribute little, if any, vegetation to the reclaimed areas. The loss of the seed, together with the loss of plant parts that often grow into plants, would lower the vegetative diversity of reclaimed land.

Despite the drawbacks of prolonged storage, Consol's revegetation plan follows state-of-the-art techniques based on reclamation experience at other mines in southeastern Montana. For example, the company would seed reclaimed areas in two steps. Initially, plants considered poor competitors for moisture and nutrients (i.e., forbs, shrubs, and warm-season grasses) would be seeded. They would be given two years for establishment. Meanwhile, Consol would plant shrub seedlings to replace those that die. The company would also plant tree seedlings in designated areas. At the end of two years, a mixture of mostly cool-season grasses would be interseeded into the reclamation areas.

This sequential planting method is intended to help forbs, shrubs, and warm-season grasses overcome the competitive advantage that cool-season grasses have when all are seeded together. The purpose is to improve diversity. Consol plans to further enhance revegetation by planting in the fall, when possible. Fall planting appears to yield slightly better establishment success for native species (De Puit et al., 1978).

The number of acres that Consol proposes to plant of each postmining vegetative community is about the same as the number of acres of each today (table 3-9). One exception is that reclamation would yield 42 acres less of the shrub/grassland community and 42 more of the conifer/shrubland community. This would stem from Consol's revegetating the existing "breaks" type, a shrub/grassland community, with the conifer/shrubland unit seed mix. The reason for this is that the conifer/shrubland revegetation mix most closely resembles what now grows in the "breaks" community. (See app. C.) As a result, despite the apparent changes in acreage, almost no difference in major community acreages would result after mining. (Ponderosa pine and Rocky Mountain juniper would be included with the conifer/shrubland mix only where these species are found today.)

ALTERNATE RECLAMATION AND GRAZING PLAN

Areas identified in Consol's vegetation inventory as special use pastures would be returned to the same

TABLE 3-9

Comparison of Pre- and Postmining Vegetation Communities in the Proposed 12-Year Disturbance Area

Premining Community Type	Acres to be Disturbed	Postmining Revegetation Unit[1]	Postmining Acreage
Shrub/Grassland Communities		**Shrub/Grassland Communities**	
Big sagebrush/Western wheatgrass	220	Sagebrush/Grassland	575
Big sagebrush/Bluebunch wheatgrass	330		
Big sagebrush/Needle-and-thread	25		
Breaks	42		
Silver sagebrush/Western wheatgrass	22	Drainage ways	33
Greasewood/Western wheatgrass	11		
Subtotal	650	Subtotal	608
Conifer/Shrubland Communities		**Conifer/Shrubland Communities**	
Rocky Mountain juniper/Bluebunch wheatgrass	22	Conifer/Mixed shrubland	74
Ponderosa pine/Bluebunch wheatgrass	10		
Subtotal	32	Subtotal	74
Grassland Communities		**Grassland Communities**	
Needle-and-thread/Blue grama	8	Sod-forming grassland	129
Western wheatgrass	113		
Prairie sandreed	8		
Bluebunch wheatgrass/Broom snakeweed	4	Ridgetop grassland	4
Subtotal	133	Subtotal	133
Agricultural Units		**Agricultural Units**	
Improved pasture	145	Improved pasture	145
Alfalfa/Smooth brome hayland[2]	14	Alfalfa/Smooth brome hayland[2]	14
Subtotal	159	Subtotal	159
TOTAL	974	TOTAL	974

Source: Consolidation Coal Company, 1984, vol. 4.

[1] Revegetation seed mixtures and planting rates are given in appendix C.

[2] Prime farmland.

use, instead of being returned to native rangeland. These pasture areas would be reclaimed using introduced vegetation, and would be used for early-season grazing for breeding and lactating livestock.

Upon approval by the Department of State Lands, Consol would initiate a grazing plan on the revegetated areas. The objective of this plan is to determine the stability and success of revegetated areas. Annual monitoring reports of the status of these grazing trials would be given to the Department.

PRIME FARMLAND REVEGETATION

The prime farmland covered by the railroad loop could be reclaimed, but not without some impact. The prime farmland soils from the loop areas would remain stored for at least 13, and as many as 30, years. These prime farmland soils would undergo the same impacts from prolonged storage as other soils. (See Soils.) Vegetative productivity after reclamation could initially be lower than premining levels.

IMPACTS OUTSIDE OF THE PERMIT AREA

A projected increase in sodium levels in Squirrel Creek due to mining could deteriorate soils next to the creek, which could decrease vegetative productivity and, in some places, may cause vegetation failure. (See Soils and Hydrology.) The affected vegetation would be outside the proposed 12-year permit area. Consol should take steps to ensure that only high-quality water is discharged into Squirrel Creek. (See Hydrology, Mitigating Measures.)

MITIGATING MEASURES

- Consol could reduce the loss of important soil microorganisms by spreading the topsoil (including prime farmland) stockpiles over more area, exposing more soil for sustaining rootzone organisms. (See Soils.)

AQUATIC ECOLOGY

Summary of Impacts: The species composition and productivity of macroinvertebrates (aquatic "bugs") and algae in Squirrel Creek, the Tongue River, and the Tongue River Reservoir may change as a result of the increased nitrate and ammonium concentrations from mining. A change could also occur in the Tongue River and Tongue River Reservoir if as many as 11 mines are built in the Tongue River Reservoir watershed. It is not possible to confidently predict the magnitude of such changes; however, calculations indicate that water quality criteria for the protection of aquatic life would be exceeded during certain seasons.

EFFECTS OF THE CX RANCH MINE

Only the water pumped from the mine pit would affect aquatic ecology. No other source of water contamination is predicted. The Squirrel Creek channel and adjacent low terraces are not proposed to be disturbed. Discharge from the sediment ponds would be similar to ephemeral runoff water today.

Part of the pit inflow water would be used for dust control. But the excess would be discharged to an ephemeral tributary of Squirrel Creek. This water has a lower concentration of total dissolved solids (TDS) than does Squirrel Creek; consequently, the TDS concentrations in Squirrel Creek would decrease. However, the sodium adsorption ratio (SAR) would nearly triple. This would occur because the water pumped from the pit would be low in calcium and magnesium (Consolidation Coal Company, 1984, vol. 8, bk. 1, p. 67); the sodium concentration would increase by about 14 percent. (See Hydrology.) The pumpage water contains very low concentrations of metals (Consolidation Coal, 1984, vol. 8, bk. 1, pp. 67, 68); thus metal concentrations in Squirrel Creek are not expected to increase.

Other prairie streams in southeastern Montana that exhibit water quality characteristics similar to those predicted for Squirrel Creek maintain macroinvertebrate and algae populations similar to those now in Squirrel Creek (Klarich et al., 1980). However, increase in ammonia (NH_3), nitrate/nitrite (NO_3/NO_2), and hence total soluble inorganic nitrogen (TSIN) concentrations in Squirrel Creek could cause changes in the macroinvertebrate and periphyton (the organisms growing on submerged surfaces) communities. The relative abundance of certain algal species may change (Rhee, 1978; Smith, 1983).

Primary productivity (total algal growth) may not change at all. If the ratio (R) of TSIN (as N) to available phosphate (PO_4 as P) is greater than 10:1, the stream is considered to be phosphorous limited (Zison et al., 1977). Squirrel Creek can be assumed to be phosphorous limited since $R = 30.8$ (TSIN [N] $= 0.452$ and $PO_4(P) = .016$ [average of 37 measurements]). Since only TSIN is expected to increase, R would also increase and no further growth of algae would be expected. Only an increase in phosphorous would enhance primary productivity.

Changes in species composition of the macroinvertebrate population may occur because composition of the food source (periphyton) may change. Once again, the magnitude of these changes cannot accurately be described.

Consol would monitor the water quality and macroinvertebrate and periphyton communities beginning one year before initial ground-breaking, in April, September, November, and January (if ice conditions allow) during mining.

The sampling sites would be located (1) upstream of the mine (serving as the baseline station), (2) downstream at a point between the proposed pump discharges from the Consol CX Ranch Mine and KME Wolf Mountain Mine, and (3) downstream near the Decker Store. Seasonal reports containing taxonomic species lists, community changes, density, and diversity values would be prepared (Consolidation Coal, 1981, vol. 4, pp. 4-151a–4-151c).

The effect on species composition and abundance of periphyton and macroinvertebrates in the Tongue River and Tongue River Reservoir, because of the increase in nitrates and ammonia, would be small. (See Hydrology.)

CUMULATIVE IMPACTS

The increase in total dissolved solids (TDS) and nitrogen concentrations in Squirrel Creek caused by the Wolf Mountain Mine and the CX Ranch Mine together could cause a change in periphyton and insect species diversity and relative abundance (Klarich and Regele, 1980; Bahls, 1980; Telman, 1977). The increased total nitrogen concentration in Squirrel Creek would not change the total numbers of algae and macroinvertebrates. The change in community structure cannot be accurately predicted. The monitoring program would describe such changes, after mining begins.

In the Tongue River, discharge waters from the two mines would be greatly diluted. Hence, TDS and nitrogen contributions would also be greatly diluted. The effect, if any, of Squirrel Creek nitrogen and TDS on aquatic organisms in the Tongue River would be small.

The total nitrogen concentrations in the Tongue River Reservoir may increase, caused by the discharge of as many as 11 mines. (See Hydrology.) The reservoir is considered to be nitrogen restricted (U.S. Environmental Protection Agency, 1977; Whalen, 1979). That is, algal growth is limited by the amount of nitrogen present. Therefore, the increase in nitrogen from mining may cause an increase in the amount of algae in the reservoir. The resulting nuisance blooms could mar the recreational value of the reservoir (Whalen, 1979). The nitrogen increase may also cause changes in algal community structure. Changes in the relative abundance and diversity of aquatic insects could also occur. The extent of growth and which species would be affected are not known.

MITIGATING MEASURES

- Reducing the nitrogen concentration in the discharge water, or a seasonal reduction in the amount of water discharged, would minimize the potential changes in the Squirrel Creek insect and algal populations.

- Changes in the insect and algal populations in the Tongue River Reservoir could possibly be detected by implementing a monitoring program similar to the one proposed.

FISHERIES

Summary of Impacts: Mining discharge water would increase concentrations of toxic un-ionized ammonia in Squirrel Creek. Under extreme conditions, the increase would lead to summer fish kills and the avoidance of a potential spawning ground at the mouth of Squirrel Creek. The Environmental Protection Agency (EPA) 30-day criteria for un-ionized ammonia could be exceeded in Squirrel Creek, depending on combinations of ammonia, pH, and temperature. If 11 mines operate simultaneously along the Tongue River, EPA 30-day and maximum allowable criteria would be exceeded (under extreme conditions) in the Tongue River and Tongue River Reservoir. When the mines stop discharging pit pumpage, affected waters would again become suitable for fish.

EFFECTS OF MINING

Mining at the CX Ranch and Wolf Mountain mines would affect fish mainly by raising levels of ammonia. (See Hydrology.) Although the mines would also raise nitrate levels—possibly enough to increase algae growth in the Tongue River and reservoir (see Hydrology and Aquatic Ecology)—this increase would not harm fish populations. Changes in other water quality characteristics would not affect fish populations. When mining ends, water quality would return to premining conditions, allowing fish to again use affected waters.

AMMONIA TOXICITY AND PROTECTION CRITERIA

Ammonia is toxic primarily due to its un-ionized fraction (European Inland Fisheries Advisory Commission, 1973; Fava et al., 1981). The lowest lethal concentration of un-ionized ammonia for salmonids (trout and salmon) is about 0.2 mg/l (European Inland Fisheries Advisory Commission, 1973; Fava et al., 1981). However, prolonged exposure at concentrations as low as 0.025 mg/l can cause adverse effects (European Inland Fisheries Advisory Commission, 1973). Flis (1968) found that continued exposure to sublethal levels of un-ionized ammonia degenerates certain tissues. Growth rates may also be suppressed. Species of the sunfish, minnow, and catfish families, common in waters near the minesite, (tables 2-8, 2-9, 2-10) are more tolerant of un-ionized ammonia than are salmonids. Fava et al. (1981) list the following 4-day LC_{50} values (lethal concentration for at least 50 percent of the population): sunfish family, 0.3 to 1.7 mg/l; minnow family, 0.3 to 2.5 mg/l; and catfish family, 1.5 to 3.75 mg/l.

In 1976, the Environmental Protection Agency established a criterion of 0.02 mg/l of un-ionized ammonia to protect freshwater aquatic life (U.S. Environmental Protection Agency, 1976). However, the most recent protection criteria (U.S. Environmental Protection Agency, 1983) vary: They depend on pH and temperature, which influence both the proportion of total ammonia which becomes un-ionized and the toxicity of un-ionized ammonia to fish. The EPA gives two levels of protection criteria: the maximum allowed concentration ("maximum") and the more easily exceeded 30-day average allowed concentration ("30-day"). Exceeding the maximum criteria has the potential for killing fish, while exceeding the 30-day criteria may prompt symptoms of chronic poisoning.

Premining data on seasonal temperatures and pHs (app. G) were combined with predicted ammonia levels (tables 3-3, 3-6, 3-7) to estimate the amount of un-ionized ammonia present today and during mining in Squirrel Creek and the Tongue River. (Ammonia levels predicted for Squirrel Creek would be most likely to occur during summer; those predicted for the Tongue River would be most likely to occur during summer or winter.) These estimates were compared to EPA (1983) criteria (app. G). Because un-ionized ammonia concentrations exceeding EPA criteria would not necessarily kill fish, predicted concentrations were also compared to LC_{50} values for the fish of Squirrel Creek and the Tongue River (Fava et al., 1981). (EPA criteria are based on salmonids and are conservative.)

SQUIRREL CREEK

CX Ranch Mine Impacts

Calculations show that EPA 30-day criteria are already being surpassed, even without mining. This occurs during summer with average water conditions. Under extreme conditions (combination of highest pH, temperature, and ammonia), both the 30-day and maximum criteria, together with LC_{50} values, are exceeded. It is therefore possible that undetected fish kills have occurred in Squirrel Creek.

With mining, under average conditions, un-ionized ammonia levels would rise above both the 30-day and maximum criteria during summer. The levels however, would remain well below LC_{50} values. Under extreme conditions, un-ionized ammonia levels would rise above both EPA criteria and LC_{50} values. Summer fish kills would then result.

Cumulative Impacts

In the cumulative scenario, both the CX Ranch and Wolf Mountain mines would discharge mine pit inflows into Squirrel Creek. The Wolf Mountain Mine would account for over 70 percent of the inflow discharge. (See Hydrology.) The impacts of the two mines together would be greater than the impacts of mining only at the CX Ranch. EPA criteria would be exceeded by even greater amounts under both average and extreme conditions. LC_{50} values would likewise be exceeded by greater amounts, but only under extreme conditions. Summer fish kills would be more certain and more severe than if the CX Ranch Mine operates alone.

Mouth of Squirrel Creek—June Only

The mouth of Squirrel Creek is a potential spawning ground for smallmouth bass and several nongame species (Brown, 1974) during June. (See chapter 2, Fisheries.) Calculated levels of un-ionized ammonia before mining at the mouth occasionally, under extreme conditions, rise above both EPA criteria. (See app. G.) The lower limit of the LC_{50} range is slightly surpassed. Water quality may, therefore, limit the use of the mouth by spawning fish. Un-ionized ammonia levels due to mining (under average conditions) would not exceed EPA criteria. However, under extreme conditions, Consol's mining would make the mouth unsuitable for spawning. LC_{50} values, in addition to EPA criteria, would be exceeded. The discharge of additional inflows by the Wolf Mountain Mine would make these impacts more certain and more severe.

TONGUE RIVER AND RESERVOIR

Prior to development of Sheridan's water treatment plant (1983), un-ionized ammonia concentrations in the Tongue River exceeded EPA 30-day criteria. (See Hydrology.) Concentrations now fall below EPA criteria. Mining, even with 11 mines in the Tongue River watershed, would affect fish populations only under extreme conditions. Combined with low flows, high pHs, and high temperatures, un-ionized ammonia levels would rise above both EPA criteria during summer. However, LC_{50} values would not be surpassed, meaning that fish kills cannot be definitely predicted. Extreme conditions during winter would cause un-ionized ammonia levels to surpass only the EPA 30-day criteria. Changes in ammonia levels of the reservoir would probably be somewhat similar to those in the river.

MITIGATING MEASURES

- Consol or Kiewit Mining and Engineering could conduct further studies before mining begins. Fishery resources of the Tongue River between the state line and the reservoir should be determined. The bottom of the mouth of Squirrel Creek should be evaluated for its suitability as a spawning substrate.
- Fish populations in Squirrel Creek and the Tongue River could be monitored during mining. The data should be compared to premining data to determine if populations are changing. Some fish should be examined for signs of chronic poisoning. Any fish kills should be reported to the Department of State Lands, the Environmental Protection Agency, and the Department of Fish, Wildlife, and Parks. The Department of Health and Environmental Sciences would probably require mitigating measures to assure that the water is not degraded and fish populations are protected.
- After mine closure, fish populations of Squirrel Creek could be evaluated. If populations are significantly below premining populations, Consol, in cooperation with the Department of Fish, Wildlife, and Parks, could re-introduce appropriate fishes.

WILDLIFE

Summary of Impacts: Roughly 150 acres of pronghorn winter range would be removed by mining in the 12-year permit area. A sage grouse wintering area would also be eliminated. Regional effects on these species would not be significant. Three raptor nest sites would be destroyed and other raptors may desert their nests. Successful reclamation would make mined areas habitable by wildlife, although populations of some species would take decades to recover.

WILDLIFE HABITAT

Mining, as proposed, would eventually destroy about 974 acres of wildlife habitat. In the 33-year plan, the operation would mine through another 2,000 acres. Mining at the proposed Wolf Mountain Mine would disturb still another 1,180 acres.

Mining disturbance within the 12-year permit area would primarily remove sagebrush/grassland, perennial grassland, and cultivated habitat types. Mining would also remove about 82 acres of the area's coniferous woodlands and breaks, which supply cover for birds and mule deer. Reduced plant productivity and localized vegetation failure along Squirrel Creek (see Vegetation) would lower habitat quality for white-tailed deer, pheasants, and some other species.

BIG GAME

Consol's mining activities would destroy some areas used by mule deer. The effect on the deer would be minor. The Wolf Mountain Mine, in contrast, would destroy 165 acres of mule deer winter range. Along with removal of their habitat, deer may be forced off some ridges by mining activity as mining approaches. Mining may also discourage deer use of cultivated land along Squirrel Creek.

Consol and Kiewit Mining and Engineering would replant disturbed mule deer habitat with shrubs, including sagebrush, to provide a mosaic of shrubland and grassy areas. Although both companies would revegetate to create plant diversity, the effects of prolonged soil storage would keep diversity below premining conditions for an unknown time period. (See Vegetation.) Decreased plant diversity and vigor would lower postmining habitat quality somewhat for deer and other wildlife species. Outside the permit area, prescribed burning would be used to encourage production of deer forage within undisturbed sagebrush/grasslands. Draws, replanted with shrubs, would provide fawning areas.

If deer road kills become a problem, both companies would use a combination of deer-proof fences, underpasses, and special gates to redirect deer movements on the minesites. Increased traffic on FAS 314 (see Transportation) would result in noticeably more road kills. Kiewit Mining and Engineering would attempt to reduce road kills of mule deer by placing deer corssing signs along the road. The company would also work with the Department of Fish, Wildlife, and Parks in developing measures to reduce the excessive road kills that could occur.

Mining activities in the 12-year permit area would remove about 150 acres of lands used by pronghorn during the severe 1977–1978 winter. The proposed Wolf Mountain Mine may also eliminate some pronghorn winter range. These areas would be replanted with sagebrush and native, perennial grasses, important components of pronghorn habitat. Water developments and prescribed burns outside the permit area would enhance undisturbed sagebrush/grasslands for pronghorn. After mining, new fences in the permit area would be built to allow for passage of pronghorn.

Water quality changes due to mining would somewhat decrease white-tailed deer habitat along Squirrel Creek. Also, mining activities may disturb and temporarily displace some mule deer.

Human disturbances (hunting, harassment) of deer, pronghorn, and other wildlife on the CX Ranch permit area would be minimal. Consol proposes several measures, including prohibiting firearms, that would reduce impacts. Wildlife living in the Wolf Mountain permit area would be exposed to increased human disturbances. However, these disturbances would probably not significantly affect wildlife populations.

OTHER MAMMALS

Mining would destroy habitats of other mammals, such as mice, ground squirrels, and rabbits, along with deer habitat. The mining companies would revegetate mined lands with plants that provide food and cover for these affected species and establish rock and brush piles for species cover. Mining would not disturb riparian (streamside) areas, but localized vegetation failures would reduce habitat for some mammals.

BIRDS

Upland Game Birds

Mining activities in the 12-year permit area would destroy much of a sage grouse wintering area. This wintering area would be replanted with sagebrush. Sage grouse habitat adjacent to the 12-year permit area would be improved during mining by prescribed burning. Water developments modified for upland game birds would supplement existing water sources.

As 33-year plan operations approach to within 0.5 miles of the Twin Buttes strutting grounds, noise and dust may force some grouse off this breeding area. Consol expects to reduce these affects by not blasting in early morning during breeding periods (March–April).

Impacts on sharp-tailed grouse and gray partridge would be minimal. Development of water sources and revegetation of the permit area would improve habitat for these birds.

Pheasant and waterbird habitats along Squirrel Creek would probably be affected by mining. Consol would regulate livestock grazing to improve riparian vegetation used by upland game birds. This may partially compensate for decreased plant productivity.

Raptors (Birds of Prey)

Three raptor nest sites would be removed by mining: one prairie falcon nest site, one great horned owl nest, and one kestrel nest. Two additional nests—one prairie falcon and one kestrel—would be destroyed by the Wolf Mountain Mine.

Other raptor nests would be subjected to disturbance from nearby human activities, a major factor in nesting failures (Snow, 1973; U.S. Fish and Wildlife Service, 1976). In the Squirrel Creek area, golden eagles and, to a lesser extent, red-tailed hawks are most likely to desert their nests. Two nests could be affected by Consol's operation: a golden eagle nest within one mile of the 33-year plan and one red-tailed hawk nest on

Squirrel Creek one-eighth mile from the mining pit. The Wolf Mountain Mine could also affect the Squirrel Creek nest, along with a nest within one mile of the Wolf Mountain permit area. In addition to effects on nests, mining would reduce the number of prey animals.

Impacts on raptors would be reduced by the plans to improve habitat for small mammals, the raptors' major prey. In addition, the companies would supply snags for perching, nest boxes for kestrels, and nest cavities blasted in sandstone cliffs along Squirrel Creek for prairie falcons. All raptors, especially golden eagles and prairie falcons, would be monitored for impacts to provide recommendations for mitigation. In accordance with the Migratory Bird Treaty Act (16 USC 703), the U.S. Fish and Wildlife Service has evaluated impacts on golden eagles and prairie falcons and would supervise monitoring and construction of next cavities (J.G. Wood, pers. com., April 25 and June 11, 1984).

Other Birds

Passerine birds, primarily songbirds, have small home ranges. Most tolerate man and would move only from disturbed sites. Regionally, impacts on passerines would be insignificant, since most species are widespread. Other factors would also keep impacts low: (1) more suitable habitats lie nearby, (2) revegetation would include diverse woody and herbaceous plants, (3) brush and rock piles would be placed on reclaimed lands, and (4) Squirrel Creek riparian habitat would not be mined.

REPTILES AND AMPHIBIANS

By destroying habitat and lowering the number of small prey mammals, mining would reduce the numbers of reptiles and amphibians. Populations are expected to recover as revegetated habitats recover and as small mammals return. Rock piles would furnish reptiles with additional cover.

THREATENED AND ENDANGERED SPECIES

The Office of Surface Mining prepared a biological assessment of the potential impacts of proposed mining on the peregrine falcon, the bald eagle, and the black-footed ferret (app. F). The Office of Surface Mining concluded that the proposd action would affect neither the peregrine falcon nor the bald eagle, and the U.S. Fish and Wildlife Service has concurred with this conclusion (app. F). Both Kiewit Mining and Engineering and Consol would report future observations of threatened and endangered species to the Department of State Lands.

The Office of Surface Mining would require Consol to resurvey the prairie dog town in the proposed permit area (app. F) to check for black-footed ferrets. Kiewit Mining and Engineering plans to resurvey the prairie dog town in its permit area. Both surveys would be conducted within one year before disturbance, using methods described by Clark et al. (1984) or other approved Fish and Wildlife Service methodology. Survey results would have to be submitted to and approved by the U.S. Fish and Wildlife Service before mining proceeded.

MITIGATING MEASURES

- Consol could monitor wildlife killed along FAS 314 and report results to the Department of State Lands and the Department of Fish, Wildlife, and Parks. If road kills are excessive, the company and both State agencies could develop a plan to reduce road kills.

- Kiewit Mining and Engineering could prohibit firearms on the Wolf Mountain Mine permit area and develop other policies to reduce human disturbances of wildlife.

CLIMATE

Mining at the CX Ranch Mine would not affect the climate. Suspended particulate would remain at or near ground level, and total particulate emissions would be too small to affect either precipitation or radiation balance (Montana Department of State Lands and U.S. Office of Surface Mining, 1983, p. 3-52).

AIR QUALITY

Summary of Impacts: The CX Ranch mining operation would meet all Montana and Federal primary Ambient Air Quality Standards, even during maximum production. However, during at least one year of peak coal production, the maximum annual average total suspended particulate (TSP) concentration along the Decker highway is predicted to increase from a maximum premining level of 29.9 micrograms per cubic meter ($\mu g/m^3$) to 63.2 $\mu g/m^3$. The greatest 24-hour TSP concentration would reach 126.3 $\mu g/m^3$, compared to a premining high of 94 $\mu g/m^3$.

EMISSIONS AROUND THE MINE

Particulate emissions from the mine would total about 1,900 tons per year at the maximum projected coal production rate (33-year mine plan) of 16 million tons annually (tables 3-10 and 3-11). Nearly 92 percent (1,748 tons) of this particulate would be noncoal (overburden and topsoil) fugitive dust (table 3-10). The major source of the dust would be overburden removal, accounting for 982 tons per year, about 52 percent of total particulate emissions. Dust emissions from truck traffic on the haul roads would total about 344 tons per year, about 18 percent of the total. Coal dust emissions from the preparation plant and from coal drilling, blasting, and removal would be minor (table 3-10).

TABLE 3-10

Particulate Emissions

Source	Coal Dust Emissions (tons/year)	Noncoal Dust Emissions (tons/year)
Fugitive Dust		
Topsoil removal	0	110
Overburden drilling	0	33
Overburden blasting	0	8
Overburden removal	0	982
Coal drilling	2	0
Coal blasting	4	0
Coal removal	17	0
Road construction and maintenance	0	168
Haul roads	0	344
Access roads	0	77
Wind erosion (including stockpiles)	0	26
TOTAL	23	1,748
Preparation Plant Emissions		
Truck dump	19	
Primary crusher	2	
Secondary crusher	5	
Conveyors and transfer points	16	
TOTAL	42	

Source: Consolidation Coal Company, 1982, pp. 5-2, 5-3.

The primary gaseous pollutants would be nitrogen oxides (NO_x) from diesel fuel combustion. Over 2,600 tons would be emitted annually during peak coal production. Ambient air quality standards would not, however, be exceeded. Smaller amounts of other gaseous pollutants would also be emitted (table 3-11). Blasting, consuming 16,700 tons of ammonium-nitrate/fuel-oil explosive annually (Earl Smith, Consolidation Coal Company, written com., Dec. 10, 1982) would emit 142 tons of nitrogen oxides (NO_x), 559 tons of carbon monoxide (CO), and 17 tons of sulfur dioxide (U.S. Environmental Protection Agency, 1980, p. 11.3-3).

Consol has submitted computer modeled air quality data in the CX Ranch Mine air quality permit application (on file, Department of State Lands). The Industrial-Source-Complex-Long-Term (ISCLT) model was used to predict annual average TSP concentrations and the Point-Area-Line (PAL) model was used to estimate maximum 24-hour TSP concentrations. Both models used peak coal production at the mine and meteorological data from Sheridan, Wyoming. These models have been approved by both the Environmental Protection Agency and Montana Air Quality Bureau (Sternberg, 1982).

The modeling indicates that Federal and Montana ambient air quality standards would not be exceeded by mining activities. The maximum increase in annual average TSP concentrations predicted by the model would be 33.3 μg/m^3. This amount, added to the highest annual background concentrations of 29.9 μg/m^3, would yield a maximum concentration during mining of 63.2 μg/m^3. Since the model is conservative, that is, tends to overpredict the actual concentrations, even the Federal seconday standard of 60 μg/m^3 would probably not be exceeded. This maximum would be reached on FAS 314, the highway passing through the permit area. The maximum would be below the Montana standard of 75 μg/m^3 (table 3-12).

Outside the permit area, the highest TSP concentrations reached would be about 45 μg/m^3, about 60 percent of the Montana standard. The annual average TSP concentrations would decrease with increasing distance from the mine. One mile from the mine, concentrations would approach background levels (fig. 3-3). On the Northern Cheyenne Indian Reservation, air quality would not be affected (Consolidation Coal, 1982, p. 9-7).

The 24-hour standard would also not be exceeded. The projected maximum 24-hour TSP concentration is about 126 μg/m^3, well below the Montana standard of 200 μg/m^3. A comparison of the projected maximum concentrations and ambient air quality standards is shown in table 3-12.

The computer modeled predictions appear reasonable, since they are similar to actual measurements at ongoing mining operations. At the Decker complex, for example, with a 1979 production of about 13 million tons, the highest average TSP concentration mea-

TABLE 3-11

Maximum Annual Diesel and Gasoline Exhaust Emissions

Source	Fuel Usage (Gallons)	Particulate (Tons)	CO (Tons)	HC (Tons)	NO_x (Tons)	SO_2 (Tons)
Diesel						
Haul trucks	9,400,000	83.2	433.3	141.0	2,463.0	146.6
Dozers	387,000	2.9	12.8	4.0	87.1	6.0
Loaders	30,000	0.4	1.4	0.5	6.1	0.5
Scrapers	288,000	3.9	14.2	6.1	60.0	4.5
Graders	93,000	1.0	3.6	0.8	17.4	1.4
	10,198,000	91.4	465.3	152.4	2,634.0	159.0
Gasoline						
Gasoline-powered vehicles	103,600	0.3	203.9	6.7	4.9	0.3
TOTAL EXHAUST EMISSIONS		91.7	669.2	159.1	2,638.9	159.3

Source: Consolidation Coal Co., 1982, p. A2-3.

Note: CO = carbon monoxide, HC = hydrcarbons; NO_x = nitrogen oxides; SO_2 = sulphur dioxide.

TABLE 3-12

TSP Ambient Air Standards and Projected Maximum Concentrations

Standard	Concentration (ug/m^3)	Projected Maximum (ug/m^3)
Montana		
24-hour	200[1]	126.3
Annual	75 (arithmetic average)	63.2
Federal primary		
24-hour	260[1]	126.3
Annual	75 (geometric mean)	49.7
Federal secondary		
24-hour	150[1]	126.3
Annual	60 (geometric mean)	49.7

[1] Not to be exceeded more than once per year.

sured (of seven monitoring sites) was 42.6 ug/m^3. For comparison, the annual average TSP concentrations measured in Helena in 1980 ranged from 40 ug/m^3 to 52 ug/m^3 with a 24-hour maximum of 250 ug/m^3; at Scobey, 1980 annual average TSP concentrations were about 20 ug/m^3 with a 24-hour high of about 115 ug/m^3 (Raisch et al., 1982, p. 76).

Consol would apply the best available control technology (BACT) to minimize the emission of particulates (Consolidation Coal Company, 1982, pp. i, ii). Furthermore, Consol would be required to treat permanent haul roads and all access roads with a chemical stabilizer (P. Driscoll, Montana Air Quality Bureau, oral com., March 23, 1982). Consol estimates that the cost for pollution control equipment would be $1.6 million (Consolidation Coal Company, 1982, sec. 1.0).

Based on the modeling submitted by Consol (Consolidation Coal Company, 1984, app. 8), the reduction in the visual range caused by mining would be negligible. (The reduction in visual range as given by the Koschmieder relationship would be 0.14 percent.)

EMISSIONS IN SHERIDAN COUNTY

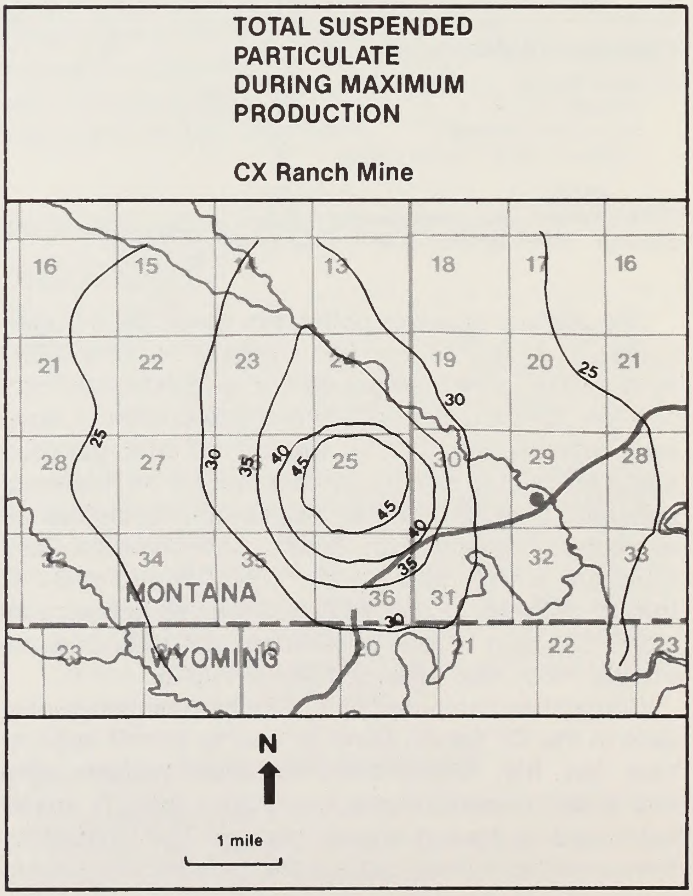
As a result of an estimated maximum population increase of about 4,200 people (14 percent) by 2005, pollutant emissions in Sheridan County may increase. Air pollution in the county stems from three major sources: wood smoke, motor vehicles (exhaust emissions and road dust) and industrial sources such as sawmills (Sheridan Press, February 2, 1982, p. 1). Many new residents could be expected to burn wood for heat and travel by motor vehicle to downtown Sheridan. This would add to the high TSP concentrations now measured downtown.

CUMULATIVE IMPACTS

Even in the cumulative scenario with three mines in full operation—CX Ranch, Wolf Mountain, and Youngs Creek—neither Federal nor Montana Ambient Air Quality Standards are expected to be exceeded. At the Youngs Creek Mine, five miles west of the CX Ranch, the maximum annual geometric mean TSP concentration measured off the permit area is predicted to be about 25 ug/m^3 (U.S. Department of the Interior, 1981, p. 3-9). Very little of this particulate, however, would reach the CX Ranch minesite. At Kiewit Mining and Engineering's Wolf Mountain Mine, just east of the CX Ranch, computer modeling (submitted in the company's air quality permit application, on file, Department of State Lands) indicates that emissions would increase annual average TSP concentrations by a maximum of about 38 ug/m^3, directly north of the KME mine. Added to the predicted annual average TSP concentration in that area of 35 ug/m^3 (from Consol's emissions plus today's concentrations), a maximum annual average TSP concentration of about 73 ug/m^3 could be expected. This maximum would still be below the Montana standard of 75 ug/m^3.

The figures given here represent extreme conditions in the cumulative scenario. The modeling relies on estimated annual particulate emissions during the max mum coal production year at each mine—2001 at C Ranch and 1990 at Wolf Mountain Mine. The actual in-

FIGURE 3-3 During mining, total suspended particulate concentrations would reach a maximum of 45 micrograms per cubic meter outside the permit area, well below Montana ambient air quality standards. More than one mile from the mine, no increases would be noticeable, since most particulate settles rapidly.



crease in TSP concentrations would therefore be less than in the extreme conditions.

In Sheridan County, pollutant emissions in the cumulative scenario would also increase over levels expected with the CX Ranch Mine alone. The county population is expected to grow by an estimated 7,500 people by the year 2000, owing to the construction of the three new mines. The extent of the pollutant increase, however, is not known.

ECONOMICS

Summary of Impacts: Both the proposed 12-year and the 33-year mine plans would increase total personal and per capita income in both Sheridan and Big Horn County. Because most new mine employees would settle in Sheridan County, most new income would accrue to Wyoming residents. High wages in the mining industry are not expected to affect wages in other sectors.

The effects of the cumulative scenario on Sheridan County would closely resemble the effects of the 33-year plan. In Big Horn County the reverse would be true. A greater proportion of Big Horn County residents would be employed in the cumulative scenario than in the CX Ranch scenarios. The county's total and per capita income would thus increase greatly.

INDUSTRIAL AND COMMERCIAL ACTIVITY

The industrial composition of the economy of Sheridan County would not be changed by the CX Ranch Mine. Coal mining and commercial development would continue to be the growth industries. In the cumulative scenario, coal development in the Decker area would become dominant. At peak employment in the year 2000, coal development would provide nearly 10 percent of total county employment, more than any other basic industry (Mountain West Research-North [MWR-N], 1985, p. 42).

The CX Ranch Mine as proposed (12-year plan) would increase the average number of commercial establishments that could be supported by the county's economy. The number would peak about 10 percent above the level that would otherwise be the case with no new mines (MWR-N, 1983, p. 8-62). Similarly, the 33-year plan would increase the number to about 15 percent more than would otherwise be the case (MWR-N, 1983, p. 8-63). In the cumulative scenario, Sheridan's current position as the region's major trade and service center would be enhanced. By the year 2000 the number of commercial opportunities would be 27 percent greater than would otherwise be the case (MWR-N, 1983, p. 10-57).

Because almost all employees of the CX Ranch Mine would live in Sheridan County, the mine would not significantly affect the level of commercial activity in Big Horn County. The level and mix of industrial activity in the county would be affected only by minesite activities. The cumulative scenario would have the potential for dramatically changing the level and mix of commercial and industrial activity in the county. These changes could result from the currently unknown level and use of tax and royalty revenue from the Youngs Creek Mine by the Crow Tribe. Such changes would be generally unrelated to the CX Ranch Mine.

EMPLOYMENT

Employment at the Mine

Consol proposes (in the 12-year plan) to start building the CX Ranch Mine in 1988. At first, the company would hire only construction workers. The number of construction jobs would peak in 1990 at an average of 213. In the second year of construction, the company would hire 198 workers for operations. Combined construction and operations employment would grow to a peak of 661 workers in 1990. Employment would begin to decline in 1997 and would drop to zero in 2000 (table 3-13).

In the life-of-mine (33-year) plan, employment would be the same as in the proposed (12-year) plan through 1996. Then, instead of declining, the number of jobs would rise, beginning with a second construction phase in 2001 to 2002, similar to the second and third years of the initial construction phase. Operations employment would stay at 938 through 2017. The mine then would go through 3 years of declining employment and would close in 2020 (table 3-13).

In the cumulative scenario, with the addition of Youngs Creek and Wolf Mountain Mines, mine employment would double, but the pattern of growth would stay the same. The construction phase of all mines together would become longer and reach a higher peak. The operations work force would grow by 1993 to a plateau of 1,169 workers, a level lasting six years, before climbing to a second plateau of 1,886 in 2005. The second plateau would be followed by a shutdown phase and eventual closing of the mines (table 3-13).

Almost all non-Indian operations workers are expected to live in the Sheridan City area, either in the city itself, the adjacent urban area, or the smaller nearby communities (table 3-14). In contrast, all Indian workers, about 7.2 percent of the construction and operations work force, are expected to come from and therefore live on the nearby Crow and Northern Cheyenne Reservations. None of the Indian mine employees are expected to move, so their expected residential pattern matches the current pattern.

TABLE 3-13

Construction and Operations Employment

	CX Proposed 12-Year Plan		CX 33-year Mine Plan		Cumulative Scenario[2]	
	Construction[1]	Operations	Construction[1]	Operations	Construction[1]	Operations
1988	8	0	8	0	126	0
1989	128	198	128	198	470	198
1990	213	448	213	448	495	683
1991		538		538	325	1,003
1992		604		604	25	1,144
1993		604		604		1,169
1994		604		604		1,169
1995		604		604		1,169
1996		604		604		1,169
1997		247		604		1,169
1998		247		604		1,169
1999		247		677		1,172
2000		0		677	150	1,372
2001			126	800	401	1,640
2002			213	938	213	1,793
2003				938		1,803
2004				938		1,853
2005				938		1,886
2006				938		1,886
2007				938		1,869
2008				938		1,816
2009				938		1,778
2010-2014				938		1,621
2015-2017				938		1,321
2018-2020				494		877

Sources: Consolidation Coal Company, written com., November 15, 1982; MWR-N, 1985, p. 34.

Note: The data in the table represent estimates provided by the mine companies. These estimates were used, as assumptions, to generate computer projections of related employment, population, and economic growth.

[1] Construction employment is expressed in full-time equivalents.

[2] Includes the CX Ranch 33-year mine plan, Wolf Mountain Mine, and Tanner and Youngs Creek Mine.

TABLE 3-14

Projected Place of Residence of Local, Non-Indian Workers

	Construction				Operations			
		Number at Peak Employment[1]				Number at Peak Employment		
Area	Percent	CX Ranch as Proposed	CX Ranch 33-year Mine Plan	Cumulative	Percent	CX Ranch as Proposed	CX Ranch 33-year Mine Plan	Cumulative
City of Sheridan	49	47	47	113	53	298	461	758
Greater Sheridan area	21	20	20	59	33	185	287	472
Ranchester-Dayton area	9	9	9	21	9	50	78	129
Decker area	0	0	0	0	5	28	44	72
Lodge Grass and SE Reservation	4	4	4	9	0	0	0	0
Crow Agency and SE Reservation	4	4	4	9	0	0	0	0
City of Hardin	13	13	13	30	0	0	0	0
TOTAL	100	97	97	231	100	561	870	1,431

Sources: MWR-N, pp. 5-17, 5-3, 5-7, 5-9, 5-10; Consolidation Coal Company, written com., November 15, 1982; Kiewit Mining and Engineering Company, written com., November 9, 1982.

Note: The data in this table represent estimates based either on current trends or on information provided by the companies. These estimates were used, as assumptions, to generate computer projections of related employment, population, and economic growth.

[1] Peak quarterly employment, rather than peak full-time equivalent employment. For the CX Ranch, peak employment would occur in the first quarter of 1990 at 317 workers. In the 33-year mine plan, a second peak would occur in 2002. In the cumulative scenario, the peak would also occur in the first quarter of 1990 at 617 workers.

About three-fourths of the Indian workers, based on the current ratio at the Decker and Big Horn Mines, would be Crow and one-fourth, Northern Cheyenne. At this ratio, Indian workers, at peak employment, would total about 43 workers at the CX Ranch Mine as proposed, about 68 in the 33-year mine plan, and about 455 in the cumulative scenario. The increase in jobs in the cumulative scenario reflects Shell Oil Company's Youngs Creek Mine lease provisions, which call for 50 percent employment of Crow tribal members. Almost all the increase in Indian jobs between the 33-year mine plan and the cumulative scenario would go to the Crow Tribe (table 3-15).

All employees for operations are expected to either come from or move permanently to the area. About two-thirds of the construction workers, in contrast, are expected to be "nonlocal" people—those who would either move temporarily (table 3-16) or commute daily or weekly.

TABLE 3-16

Residential Distribution of the Nonlocal Construction Workers

Area	Percent	Number at Peak Employment: CX Ranch as Proposed	CX Ranch 33-year Mine Plan	Cumulative Scenario
City of Sheridan	59	116	116	194
Greater Sheridan area	31	61	61	102
Ranchester-Dayton area	5	10	10	16
Decker area	5	10	10	16
TOTAL	100	197	197	328

Sources: MWR-N, 1983, pp. 5-19, 5-12; Consolidation Coal Company, written com., November 15, 1982; Kiewit Mining and Engineering Company, written com., November 9, 1982.

Note: The data in this table represent estimates based either on current trends or on information provided by the mine companies. These estimates were used, as assumptions, to generate computer projections of related employment, population, and economic growth.

Sheridan County

Prompted by rising mine employment, other employment sectors would grow. Most growth would go to the trade, service and government sectors, but employment in all other industries, except agriculture, would also rise (MWR-N, 1983, p. 8-55; 1985, pp. 41-52).

Overall, the mine as proposed would add a maximum of about 1,648 jobs—both mine and nonmine—or 10.2 percent, to total county employment. The total number of additional jobs would then decline to about 686 during the mine shutdown phase (MWR-N, 1985, p. 41).

The effect of the 33-year mine plan would be identical to the effect of the mine as proposed through about 1996. Afterwards, total employment due to the mine would rise and fall with employment at the mine: The number of jobs would increase for the life of the mine by almost 3,000, about 15.4 percent of total county employment. The employment due to the mine would then drop, reflecting cutbacks in the mine work force (MWR-N, 1985, p. 41).

Just as the development in the cumulative scenario would double the number of mine workers, it would double the total number of jobs due to mining. The peak employment increase would come around 2005 at about 3,800 jobs, or 24 percent of total county employment (MWR-N, 1983, p. 10-52).

TABLE 3-15

Residential Distribution of Local Indian Workers

Area	Construction: Percent[2]	Construction: Number at Peak Employment[1]: CX Ranch as Proposed	CX Ranch 33-year Mine Plan	Cumulative	Operations: Percent[2]	Operations: Number at Peak Employment: CX Ranch as Proposed	CX Ranch 33-year Mine Plan	Cumulative
Crow Agency and NE Reservation	32	7	7	19	25	11	17	148
Lodge Grass and SE Reservation	40	9	9	22	45	19	32	242
Central Crow Reservation	1	1	1	1	3	1	1	34
Northern Cheyenne Reservation	27	6	6	16	27	12	18	31
TOTAL	100	23	23	58	100	43	68	455

Sources: MWR-N, 1983, pp. 5-9, 5-10, 5-15; Consolidation Coal Company, written com., Nov. 15, 1982, Kiewit Mining and Engineering Company, written com., Nov. 9, 1982.

Note: The data in this table represent estimates based either on current trends or on information provided by the mine companies. These estimates were used, as assumptions, to generate computer projections of related employment, population, and economic growth.

[1] Peak total construction employment, not peak construction employment for Indians. Peak construction employment for Indians would occur during the construction of the Youngs Creek Mine, when, as a result of lease provisions, 50 percent of the employees, or about 162 people, would be members of the Crow Tribe.

[2] The percentages reported apply only to the two CX Ranch scenarios. Due to lease provisions (see footnote 1) more Crow would be employed in mining and so more miners would live on the Crow Reservation.

With the addition of the new mines in the cumulative scenario, coal mining would dominate the economic base of Sheridan County. By the early 1990s, mining would account for about 30 percent of all basic jobs (MWR-N, 1983, p. 6-82), more than any other basic industry.

Big Horn County

Because almost all mine workers would live in Sheridan County, employment in Big Horn County would grow little as a result of the mine. At maximum, the CX Ranch Mine as proposed would add about 137 jobs, or 2.6 percent, to total county employment. In the 33-year mine plan, the maximum increase would amount to about 216 jobs, or 3.3 percent.

Crow Indian Reservation

The CX Ranch Mine would have little effect on Crow Reservation employment, beyond the hiring of a few members of the tribe at the mine. Likewise, the proposed 12-year mine is expected to have little effect on the residents of the Crow Reservation (Crow Tribe of Indians, Office of Natural Resources, March 31, 1983, p. 112).

Northern Cheyenne Reservation

Both the proposed mine and the cumulative scenario would have little effect on reservation employment, beyond the employment of a few members of the Northern Cheyenne Tribe.

COMMUNITY AND PERSONAL INCOME

Sheridan County

During the peak year of construction employment, the CX Ranch Mine as proposed (12-year plan) would add as much as 8.6 percent, or $34.2 million, to total personal income in Sheridan County. This amount would then fall back slightly and later increase as operations employment increased. During the full production phase of the mine, the increase in total personal income would reach about 8.3 percent, or $36.9 million above the level with no new mines (MWR-N, 1985, pp. 54, 56).

The biggest effect on per capita income would come during the full production phase of the mine and amount to between $1 and $15, a 1- to 2-percent increase over the level without the new mine (MWR-N, 1985, pp. 54 and 56). Per capita income would increase less than total personal income, because the population would increase faster than income (MWR-N, 1983, p. 8-56).

The impacts of the 33-year mine plan would be greater, but very similar to, the impacts of the mine as proposed. The maximum annual increase in total personal income would be $50 million to $60 million and per capita income would be increased by as much as $86. Following the shutdown of the mine, both total and per capita income would decline to the level expected if the mine never opened (MWR-N, 1985, pp. 54, 57).

Big Horn County

Like employment, neither total nor per capita income in Big Horn County would be significantly affected by the CX Ranch Mine. As proposed, the mine would raise total and per capita income less than 1 percent. Even in the 33-year plan, total personal income in the county would only increase about $2.1 million and per capita income $10 to $16, or about 0.2 percent. (MWR-N, 1985, pp. 60, 63).

The impacts of the cumulative scenario would be much different, because more employees would be members of the Crow Tribe and thus Big Horn County residents. Total personal income in the county is forecast to increase $11 to $57 million, or 28 percent, during cumulative development. This increase would be enough to boost per capita income 8.2 to 26.9 percent, despite the relatively rapid rate of natural population growth in the county (MWR-N, 1983, p. 10-21; 1985, pp. 60, 65). The magnitude of the increase illustrates that growth in relatively high-wage jobs, without a significant rise in county population, can sharply increase per capita income (MWR-N, 1983, p. 10-19).

Projections of income are more uncertain in Big Horn County than elsewhere, due to uncertainties over how much the Crow Tribe would collect in royalties, whether the tribe will succeed in imposing a 25-percent coal severance tax, and how the tribe would spend the revenues collected. The tribe could collect as much as $58 million annually, assuming that currently negotiated royalty rates and current and projected coal prices hold, that the Absaloka and Youngs Creek mines run at full production, and that the tribe succeeds in imposing a 25-percent severance tax (MWR-N, 1983, pp. 4-24, 4-25, 4-135, 9-33).

The greatest uncertainty would be the use of the tribal revenue. Under one set of circumstances, for example, the $58 million in annual revenues would translate into an annual household dividend payment of nearly $13,000 ($3,600 per member, 3.61 members per household). This payment amount assumes that the current practice of distributing 60 percent of the coal revenues as dividend payments is continued, that the dividend payment does not draw a significant number of Crow back to the reservation (about 25 percent of the tribe does not live on the reservation), and that the average household size does not significantly change.

The exact effect of a $13,000 annual dividend on the personal income of Crow tribal members has not been estimated, because of the many unknowns associated with the issue (Crow Tribe, 1983, p. 95). But the effect would probably be enormous. The Crow income could significantly change the income projections for both Big Horn and Sheridan counties. The way the tribe spends such a sum could easily be the most important factor in the economic future of Big Horn County and the Crow Reservation.

SOCIAL CONDITIONS

Summary of Impacts: The CX Ranch Mine would slightly change the social organization and increase the population and housing demand in the Decker and greater Sheridan areas, mostly in the 33-year mine plan during the years 2000 through 2013. Other parts of the region would not be significantly affected by the mine.

Development in the cumulative scenario would significantly increase the population and housing demand in the Decker area, Sheridan City, greater Sheridan area, and in Ranchester and Dayton. Social organization would be substantially affected in the Decker area and, to a smaller degree, in Sheridan City, the greater Sheridan area, and the Ranchester-Dayton area. Cumulative scenario effects would peak during the years 2007 through 2014.

IMPACTS BY AREA

Regional Social Organization

The CX Ranch Mine would have few effects on the social organization of Big Horn or Sheridan Counties, with the possible exception of the Decker area (Mountain West Research-North [MWR-N], 1983, p. 8-19). The mine would most likely do the following: slightly bolster the area economy; maintain and supplement the links of government, business, and individuals with outside agencies and people; continue to shift the prestige and influence associated with different occupations; and encourage local governments to plan and coordinate. These slight changes would go on with little population increase or new social problems.

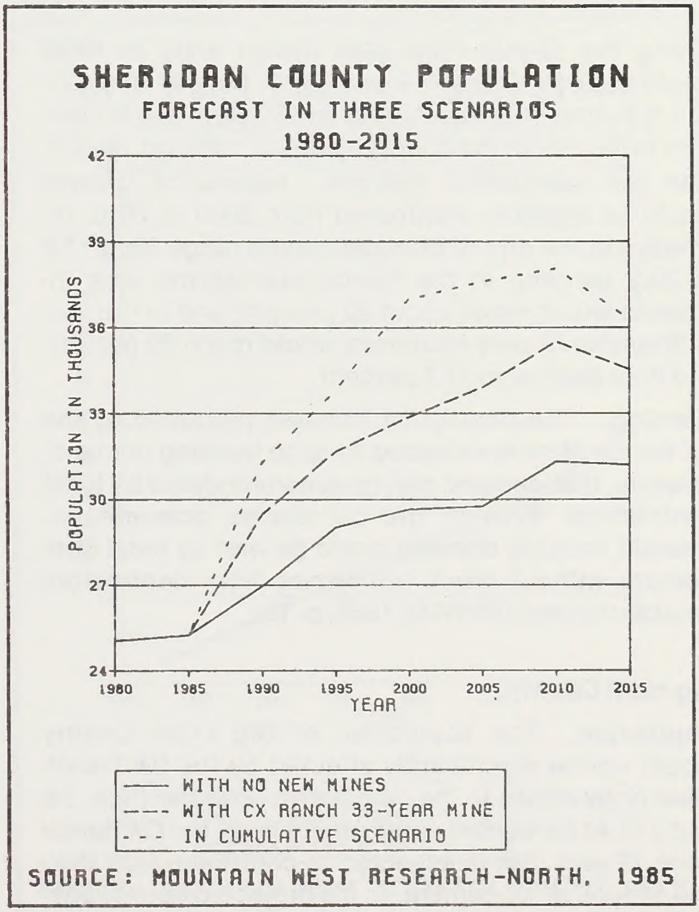
The effect of the cumulative scenario would be to magnify the impacts expected from the CX Ranch mine alone (MWR-N, 1983, pp. 10-2, 10-8). In addition, the three new mines could substantially change the economic, political, and social diversity and complexity of the region. For example, agriculture is likely to become less dominant in the economy and agricultural proprietors are likely to become less politically powerful and have less prestige. These changes would take place mostly in the Decker area and in Sheridan County, where the population would grow the most. No regional social problems, such as crime, alcoholism, or suicide, would increase due to mining.

Sheridan County

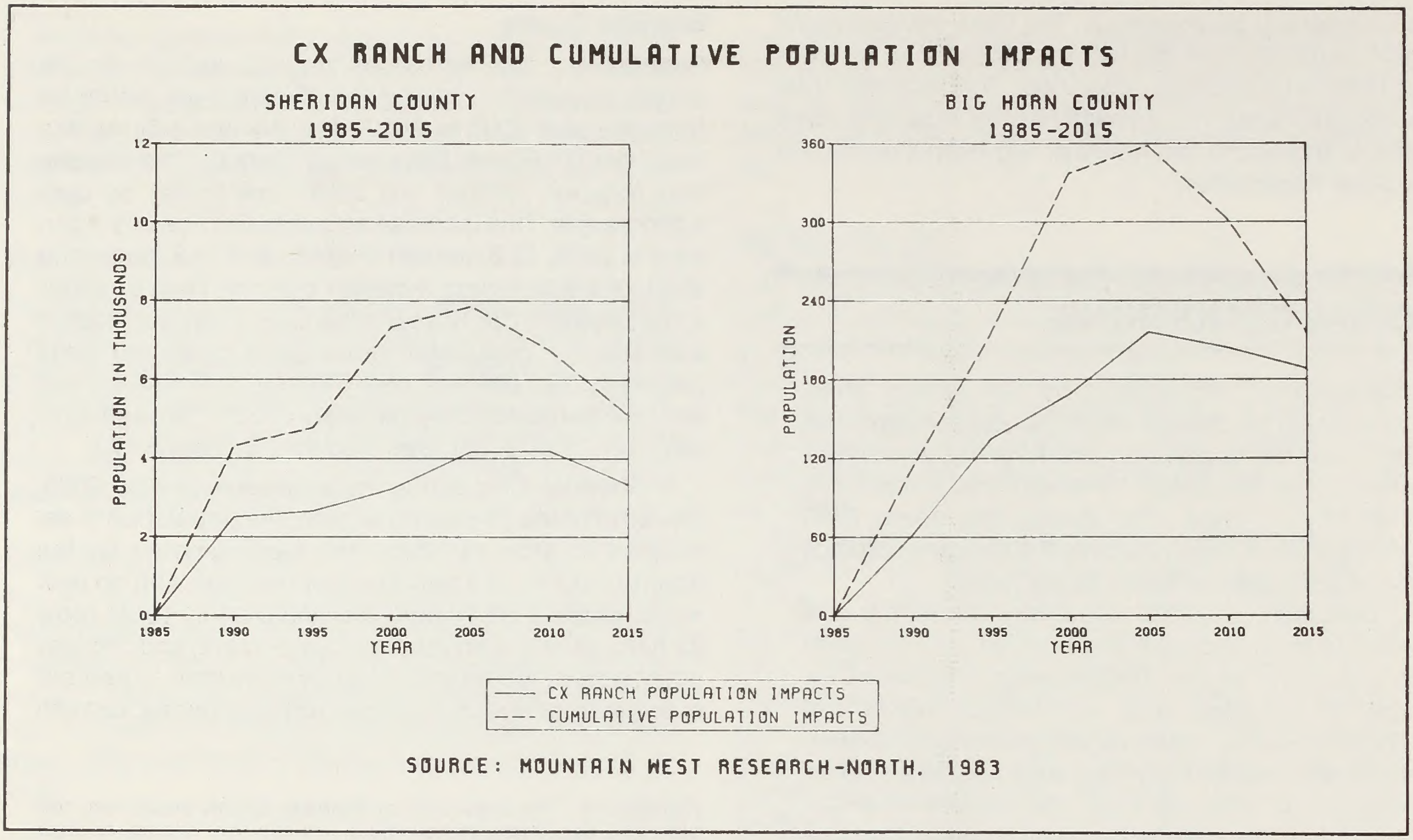
Population. The period of greatest impact on the county population, during the 33-year plan, would be from the year 2000 to 2010 (figs. 3-4 and 3-5). At this time, the CX Ranch Mine would increase the population forecast without any other new mines by over 4,000 people. This increase amounts to a rise of 9.7 percent in 2000, 12.3 percent in 2005, and 11.8 percent in 2010, or a 9.8-percent increase over the peak of about 2,700 people in the 12-year mine plan. In the cumulative scenario, the population would grow by almost 8,000 people, or 19.2 percent, over the level forecast without any new mines for the peak years of 2007 through 2014 (MWR-N, 1985, p. 35). (See also app. B, table B-17.)

In Sheridan City, during the peak years of 2000, 2005, and 2010 of the 33-year mine plan, the population is estimated to grow by about the same amount as the county—9.5 to 12.1 percent over the level with no new mines (table 3-17). Ranchester and Dayton would grow 22 percent and then decline 13.6 percent, and the rest of the county would grow slightly more than 12 percent over the level forecast without any new mines. Growth

FIGURE 3-4 The population of Sheridan County would vary considerably, depending on how much development occurs. At maximum (with the addition of three new mines in the cumulative scenario) the population would rise from 25,153 in 1984 to 38,176 in 2008, an increase of 19.6 percent (MWR-N, 1985, p. 35).



SOURCE: MOUNTAIN WEST RESEARCH-NORTH, 1985



CX RANCH AND CUMULATIVE POPULATION IMPACTS

SHERIDAN COUNTY 1985-2015

BIG HORN COUNTY 1985-2015

SOURCE: MOUNTAIN WEST RESEARCH-NORTH. 1983

FIGURE 3-5 Population increases attributable to mine development account for only a part of all population increases. (Some increase would occur anyway.) At maximum in Big Horn County, mining would increase the population by 388 people. At a maximum in Sheridan County, mining would increase the population by 4,753 people. Note the difference in scale between the graphs.

during the 12-year mine plan (which ends in 1999) would peak in 1998 at 7.9 percent in the city of Sheridan, 9.8 percent in Ranchester and Dayton, and 8.1 percent in the rest of the county (MWR-N, 1985, pp. 36–37).

In the cumulative scenario, population growth would be similarly distributed from 2000 to 2010. Increases in the city of Sheridan would range from 17.6 to 20.9 percent; in the Ranchester-Dayton area increases would reach about 22 percent; and in the rest of Sheridan County increases would reach 20 percent and then decline to 17.7 percent.

Housing. The population increase prompted by the CX Ranch Mine is expected to raise housing demand; however, that demand can be accommodated by local contractors. Even in the cumulative scenario, increased housing demand could be met by local contractors without much assistance from contractors outside the area (MWR-N, 1985, p. 10).

Big Horn County

Population. The population of Big Horn County would not be significantly affected by the CX Ranch Mine or by mines in the cumulative scenario (figs. 3-5 and 3-6). At its highest employment level, the CX Ranch Mine 12-year plan is expected to contribute less than 140 people, or 1.0 percent, to the projected county population of about 14,000. In the 33-year plan, the mine would add, at peak, under 225 people, or 1.5 percent. In the cumulative scenario, mine development would add less than 350 people, or 2.3 percent to the projected population. (See app. B, table B-16.)

None of the jurisdictions in Big Horn County are projected to grow greatly from the development of the CX Ranch Mine. Hardin may grow in the 33-year plan by about 100 people by the year 2005, contributing about 2.5 percent to the expected population of nearly 4,000. The northern portion of Big Horn County would grow by about 40 people by 1998 in the 33-year plan, an increase of about 4 percent over the projected population of over 1,000. The Decker area may grow by as many as 23 people in the 12-year plan and, in the 33-year plan, by about 40 people, an increase of 20 percent over the projected population of 200 residents in the year 2000.

The cumulative scenario would create a similar pattern. (See app. B, table B-16.) The population of Hardin would increase by about the same amount in the cumulative scenario as in the CX Ranch 33-year plan. The same is true for the northern portion of the county. The population of the Decker area, however, is projected to increase by the year 2000 by about 170 people, or 83 percent, over the population forecast without any new mines (MWR-N, 1985, p. 39).

TABLE 3-17

Population Increases from CX Ranch Mine 33-Year Plan and Cumulative Scenario: Sheridan County Areas

		Population Added by CX Ranch Mine				Population Added in Cumulative Scenario			
Year	County[1] Baseline Population	Total Sheridan County	Sheridan City	Ranchester-Dayton	Rest of County	Total Sheridan County	Sheridan City	Ranchester-Dayton	Rest of County
1985	25,250	0	0	0	0	0	0	0	0
1988	26,410	0	0	0	0	200	165	35	—
1989	26,701	642	389	51	202	2,362	1,511	184	667
1990	26,970	2,509	1,540	200	769	4,326	2,714	344	1,268
1991	27,389	2,154	1,307	176	671	5,057	3,115	409	1,533
1995	29,014	2,658	1,572	232	854	4,779	2,836	391	1,552
2000	29,650	3,221	1,906	280	1,035	7,340	4,376	624	2,340
2005	29,753	4,159	2,495	347	1,317	7,861	4,753	634	2,474
2010	31,321	4,187	2,510	347	1,330	6,743	4,075	541	2,127
2015	31,196	3,328	2,428	347	553	5,083	3,074	408	1,601

Source: Mountain West Research-North, Inc., 1985, pp. 35-37.

[1] With no new mines.

Housing. Housing demand is closely linked to population. Accordingly, increases in housing demand in Big Horn County attributable to the CX Ranch Mine would be slight. At peak, in the 33-year plan, mine-related demand would total 56 units in Hardin (in 2002), 15 units in Northern Big Horn County (in 2001), and 25 units in the Decker area (in 2001). These peak figures represent increases of about 3 percent for Hardin, 3.5 percent for the northern section of the county, and 23 percent for the Decker area over the level of housing demand expected without any new mines (MWR-N, 1983, pp. 8-19, 8-28).

In the cumulative scenario, housing demand would increase little over the level expected for the CX Ranch Mine alone. This would be true for Big Horn County, the northern section of the county, and Hardin. In the Decker area, however, mine-related housing demand would peak at about 85 units in 2002, an increase of 79 percent over the level forecast without any new mines (MWR-N, 1983, pp. 10-23, 10-33, 10-37, 10-38).

Crow Reservation

Neither the CX Ranch Mine nor cumulative development is expected to cause people to move to the reservation. Accordingly, no population or housing impacts are projected from new mining in the area (MWR-N, 1983, pp. 8-42, 8-45, 10-38, 10-40).

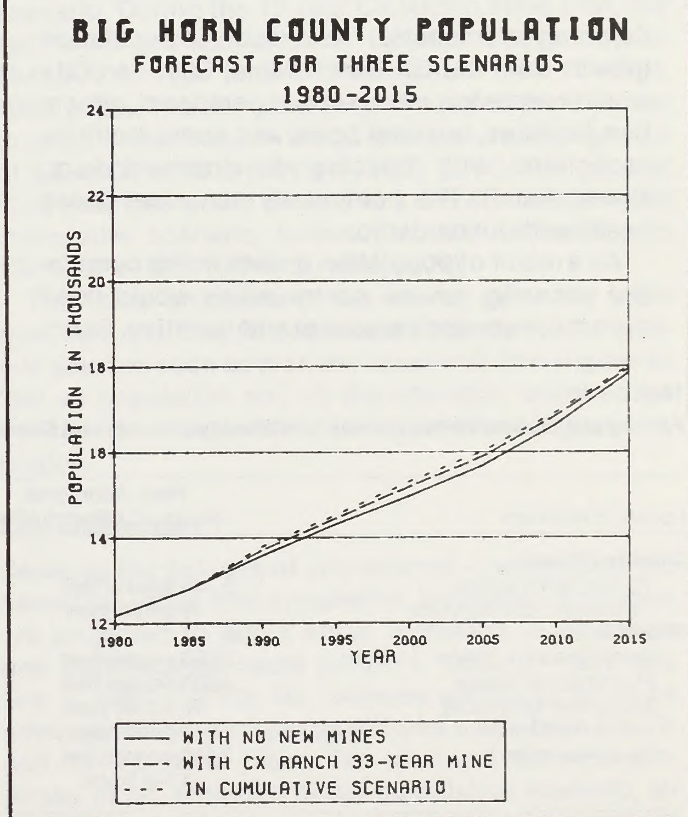
Northern Cheyenne Reservation

Neither CX Ranch Mine nor cumulative development is expected to cause people to move to the reservation. No population or housing impacts are therefore expected (MWR-N, 1983, pp. 8-49, 10-50).

MITIGATING MEASURES

The CX Ranch Mine would have too little an effect on social conditions to require mitigating measures. But combined with other planned mines (the cumulative scenario), the mine would trigger the need for mitigation. The mining companies and government agencies could share the responsibility for reducing impact. One way to determine each party's share would be to

FIGURE 3-6 Nearly all Decker area mine workers would live in Wyoming. As a result, the population of Big Horn County, Montana, would increase little from mine development. Most population increases would come from growth unrelated to mining in the Decker area.



SOURCE: MOUNTAIN WEST RESEARCH-NORTH. 1983 create a coordinating organization similar to the Colorado Joint Review Process, a group that has operated successfully to reduce and manage impacts in a situation similar to that in the Decker area. (The process is described in Freudenthal et al., 1983.) This organization would need to address the potential impacts of each mine on population distribution and housing. The following are mitigation techniques used in similar circumstances.

- Providing camps for temporary, especially single, workers.
- Employing local residents when possible.
- Encouraging workers moving into the area to locate where facilities and services already exist by providing information, assistance, or incentives to employees, developers, financial institutions, and local governments.
- Making housing more affordable by helping buyers, sellers, developers, or financing agents. The aid could include development incentives, such as interest rate buy-downs, mortgage underwriting, purchase guarantees, and payments for developing facility and service improvements.

SOCIAL AND COMMUNITY SERVICES

Summary of Impacts: As a result of population growth from the CX Ranch Mine, Sheridan City would need a few more service personnel, education facilities, hospital beds, and some facilities associated with housing development (e.g., sewer, water). The community can meet these needs without hardship.

As a result of population growth in the cumulative scenario, several communities would need even more service personnel and facilities. Sheridan City would need more water and sewer capacity and administrative and public works space. Sheridan County would need more school space, shop space, and fire station space. Ranchester and Dayton would need additional library facilities.

IMPACTS BY JURISDICTION

Sheridan County

Even without the development of new mines, the population of Sheridan County, Sheridan City, Ranchester, and Dayton will expand, and this expansion in turn will increase the need for some facilities and services. (See chapter 2.) CX Ranch Mine development would further raise the population and the need for personnel. The need for facilities, however, would not increase, except for needs associated with public works space (table 3-18).

School district 1 would have adequate capacity to accommodate growth due to the CX Ranch Mine. Under the cumulative scenario, additional facilities and teachers would be needed to accommodate 100 additional elementary students (Mountain West Research-North [MWR-N], 1985, p. 30).

School district 2 would also require additional facilities and staff for elementary and high school levels. The CX Ranch Mine (33-year plan) would necessitate an expansion of the elementary schools by 300 students in 2000 to 2010. In the cumulative scenario, additional capacity would be needed in the elementary schools (150 students) and the high schools (160 students) (MWR-N, 1985, p. 30).

Sheridan City would require additional public works and administrative space, personnel, and law enforcement and protection services due to the development of the CX Ranch Mine. Cumulative scenario development would affect the same city services, but to a greater degree (see table 3-18).

In Ranchester and Dayton, CX Ranch Mine development would not raise the need for facilities and serv-

TABLE 3-18

Facility and Personnel Requirements in Sheridan County and Sheridan City, 1988-2015

Location and Item	Peak Additional Need—CX Ranch Mine	Peak Additional Need—Cumulative Scenario
Sheridan County		
Public works space	5,400 square feet	10,200 square feet
Personnel (countywide)	19 employees	35 employees
Sheridan City		
Administrative space	2,000 square feet	3,800 square feet
Public works space	4,000 square feet	7,600 square feet
Manpower (citywide)	25 employees	36 employees
Law enforcement	2 patrol cars	3 patrol cars
Fire protection	3,500 square feet 1 fire truck	4,800 square feet 2 fire trucks

Source: MWR-N, 1985, pp. 26-27a.

ices above the amount needed with no new mines. (See chapter 2.) In the cumulative scenario, on the other hand, population increases would necessitate additional library facilities and park space.

Big Horn County

Population growth is generally the major reason a community needs more facilities or services. Since neither the CX Ranch Mine nor the development expected in the cumulative scenario would significantly increase the population, no increases in facilities or services provided by Big Horn County are expected to be needed as a result of mining (MWR-N, 1983, pp. 8-28 and 10-23).

Crow Reservation

Mining is not expected to increase the population of the reservation. Hence, any facilities and services needed in the future will stem from conditions unrelated to either the CX Ranch Mine or the development expected in the cumulative scenario. (See chapter 2.)

Northern Cheyenne Reservation

Neither the CX Ranch Mine nor the development in the cumulative scenario is forecast to increase population on the reservation. Increased facility and service needs projected for the future will therefore stem from natural population increase, not from the growth of mining. (See chapter 2.)

MITIGATING MEASURES

- No measures are necessary to reduce impacts if only the CX Ranch Mine is developed. But in the cumulative scenario a coordinating organization (described under Social Conditions) might be helpful. The organization could consider a variety of mitigating measures, such as having the companies help local governments put together 5-year capital improvement programs. Financing of these programs could come from company guarantees of public debt, advance purchase of plant investment fees, direct loans, or assistance in seeking grants or loans from State and Federal agencies.
- Other mitigating measures by the company might include financial and material help to local governments. The company, Federal, or State agencies might provide technical assistance programs or training and recruitment assistance for local technicians and professionals. Some programs could supply information about local facilities and services, the economy, and related topics.

FISCAL CONDITIONS

Summary of Impacts: More mines in the Decker area would aggravate the current fiscal imbalance between Montana and Wyoming. While spending created by mine-related development would grow sharply in Sheridan County, Wyoming, the tax base created by mining would grow mainly in Montana. As a result, Sheridan County would suffer financial strain and Big Horn County, the State of Montana, and certain Federal programs would benefit substantially. The Crow Tribe would benefit financially from the Youngs Creek Mine, a part of the cumulative scenario, but would be unaffected by the CX Ranch Mine.

SHERIDAN COUNTY

County Government

Population impacts from the proposed 12-year and the 33-year CX Ranch Mine would cause total Sheridan County general fund balances to decline; however, total revenues are projected to be adequate to cover total costs in the 12-year and 33-year CX Ranch Mine plans and in the cumulative scenario (MWR-N, 1985, pp. 69, 70, and 72). Although net fund balances would remain positive, the total net balance would decline in each scenario. During the 12-year CX Ranch Mine plan, the estimated general fund net balance would drop to $649,000 in 1998 from $1.1 million in 1988 (MWR-N, 1985, p. 69). The net general fund balance is projected to decline even more in the 33-year plan, reaching a low of $364,000 in 2010 (MWR-N, 1985, p. 70). Net general fund balances would decline to $129,000 in 2009 in the cumulative scenario, before gradually increasing to $301,000 in 2015 (MWR-N, 1985, p. 72).

The fiscal problems of the county generally stem from two sources: (1) continued dependence on revenue sources such as property taxes that do not grow as fast as population and (2) the operation and maintenance of ever larger facilities required for a bigger population.

City of Sheridan

Because the sources of city revenue—particularly the sales tax—grow with population, increases in revenue are projected to about equal increases in operation and maintenance costs (MWR-N, 1983, p. 4-202 and app. C, table C-3.7c). Tax revenues are projected to be adequate to cover city expenditures under both the 12- and 33-year mine plans. Tax revenues are also projected to be adequate in the cumulative scenario, although net surpluses are projected to decline through 2014 (MWR-N, 1985, pp. 73-78).

Dayton and Ranchester

The financial outlook for Dayton and Ranchester if additional mines are built in the Decker area parallels the outlook without new mines. However, while Ranchester is projected to have adequate revenues and general fund surpluses with or without any new mines, Dayton is projected to have general fund deficits beginning in 1990 without any new mines.

Deficits would be increased by the CX Ranch Mine. Beginning in 1990, annual deficits in the 12-year mine plan would be $82,000 above the amount projected without the mine; in the 33-year plan, the mine would generate annual deficits $8,000 above the level forecast without any new mines. The impact of all development in the cumulative scenario would cause Dayton general fund deficits to reach $201,000 above the level forecast without any new mines (MWR-N, 1985, pp. 85–89). Deficit spending, however, would not occur over an extended period. The local governing body can adjust tax rates to raise the amount of revenue necessary to cover expenditures.

Services currently provided by Ranchester and Dayton are adequate to serve up to 2,000 residents in each community. The communities would need to expand library services to adequately serve the projected population in the cumulative scenario (MWR-N, 1985, p. 28).

Ranchester and Dayton schools have adequate capacity to serve the population expected from both the 12- and 33-year CX Ranch Mine plans. However, the elementary school in Ranchester would reach capacity in the cumulative mine scenario in 2000 (MWR-N, 1985, p. 29).

BIG HORN COUNTY

County Government

The CX Ranch Mine as proposed would sharply expand the county tax base, increasing it by as much as $79 million (MWR-N, 1983, p. 8-28). But because the proposed mine would not operate after the projected closing dates of the existing mines in the county, it would not alleviate the revenue shortfalls projected after 2011. The 33-year mine plan would delay the projected revenue shortfalls, but, again, would not prevent them. In the cumulative scenario, the peak annual increase in the county tax base would be $306 million (assuming the Youngs Creek Mine is subject to county taxation, pending the outcome of the current litigation by the Crow Tribe) (MWR-N, 1983, p. 10-23). This increase would further delay, but not prevent, the revenue shortfalls in the 21st century.

Incorporated Cities

None of the incorporated cities in Big Horn County are expected to be significantly affected by the CX Ranch Mine or development in the cumulative scenario (MWR-N, 1983, pp. 8-38, 8-48).

Crow and Northern Cheyenne Reservations

Neither the Crow nor the Northern Cheyenne Reservations would be significantly affected by the CX Ranch Mine or development in the cumulative scenario (MWR-N, 1983, p. 8-45). The Crow Reservation, however, would be significantly affected by the Youngs Creek Mine, an operation unrelated to the CX Ranch Mine.

School Districts

Because the county already contributes more to the State school equalization program than it receives, the increases in the tax base would raise the county contribution to the program, rather than raising local revenues. The county would continue to contribute more than it gets back as long as the mines operate. The net effect of the CX Ranch Mine as proposed would be to increase the county contribution to the equalization program by as much as $3.2 million per year (MWR-N, 1983, p. 8-32). In the cumulative scenario, the figure would be even higher—as much as $11.8 million per year (MWR-N, 1983, p. 10-27). After the mine closes, the revenue flow would reverse and the county would receive more than it contributes.

STATE REVENUES

Over the life of the proposed 12-year mine, the State of Montana would take in a total of $427 million in various taxes (table 3-19). In the 33-year mine plan, this figure would rise to $1,712.2 million, and in the cumulative scenario, to $3,235.2 million. The State would also receive half the Federal royalties paid by the mine. Total Federal royalties would amount to about $130.6 million for the mine as proposed, $908.2 million for the 33-year plan (Consolidation Coal Company, written com., November 15, 1982), and $1,246.7 million in the cumulative scenario (MWR-N, 1983, p. 4-34).

TABLE 3-19

Total Projected State Revenues from Mining (In Millions of 1984 Dollars)

Production Tax	CX Ranch as Proposed (12-Year)	CX Ranch 33-Year Mine Plan	Cumulative Scenario
Coal severance	$403.1	$1,591.1	$3,025.2[1]
Resource indemnity trust	6.7	26.5	50.8[1]
Property tax	3.6	15.3	28.0[1]
Corporate license	13.6	55.2	102.5[1]
State royalties	0	24.1	28.7
TOTAL	$427.0	$1,712.2	$3,235.2

Sources: MWR-N, 1983, pp. 4-22, 4-25, 4-27, 4-29; 1985, pp. 109–113; Consolidation Coal Company, written com., November 15, 1982.

[1] Assumes that the State taxes would apply to the Youngs Creek Mine located on the Crow Reservation. This issue is currently under litigation.

FEDERAL REVENUES

In addition to royalties, the Federal government would receive revenue from corporate income taxes, the Black Lung Excise Tax, and the Abandoned Mines Reclamation Tax. Corporate income taxes have not been estimated, since corporate profits vary from year to year. Black Lung Excise taxes would total $41.3 million for the proposed 12-year plan, $292.2 million for the 33-year mine plan, and $545.7 in the cumulative scenario. The Abandoned Mine Reclamation Tax would total $16.4 million, $116.2 million, and $252.7 million for the three levels of mine development.

LAND USE PATTERNS

Summary of Impacts: Most impacts on land use from mining would be confined to the minesite. Effects outside the mine would be minor, not noticeably changing land use patterns in either Big Horn or Sheridan counties. Over the life of mine, 2,974 acres that are committed to a variety of agricultural land uses would temporarily be converted to mining uses. In the cumulative scenario, an additional 1,465 acres of agricultural land would be disturbed by the neighboring Wolf Mountain Mine.

MINESITE

The CX Ranch Mine as proposed would disturb 974 acres of the 25,192-acre CX Ranch. Most of the land proposed for disturbance is now being used as grazing land. The 33-year life-of-mine plan would disturb a total of 2,974 acres, almost all of which is now grazing land (chapter 2, table 2-15). Overall, the land use pattern on the CX Ranch after mining would be nearly the same as today. (See Vegetation, table 3-9.)

SHERIDAN COUNTY

Population and employment growth, rather than mining itself, would shift land uses in the county. The primary shift, from agriculture to residential acreage, would be significant.

At peak, the county would need 213 more acres of urban residential acreage for the population arising from the CX Ranch Mine as proposed, 341 acres for the 33-year mine plan, and 600 acres in the cumulative scenario (table 3-20). The maximum amount of extra land needed in the cumulative scenario would exceed by 26 percent the amount needed if no new mines are built and by 8 percent the capacity of existing subdivided lands (Mountain West Research-North, Inc. [MWR-N], 1983, pp. 8-15, 10-13).

The county would also need more rural residential land: 152 acres, at peak, for the CX Ranch as proposed, 254 acres for the 33-year mine plan, and 479 acres in the cumulative scenario (table 3-20). The amount needed in the cumulative scenario would exceed by 11 percent the amount needed with no new mines. The cumulative scenario amount would about equal the amount of subdivided acreage now in rural residential areas (MWR-N, p. 4-50). In any case, more rural land would change to residential use. Private lands that would be expected to easily handle these additional needs are plentiful (MWR-N, 1983, p. 4-50).

The need for more commercial land would be slight, amounting, at peak, to 16 acres for the CX Ranch as proposed, 18 acres for the 33-year mine plan, and 27

TABLE 3-20

Land Needed in Sheridan County, 1985–2015
(Acres)

Type of Land	1985	1990	1995	2000	2005	2010	2015
Urban residential							
Need without new mines in Decker area	1,704	1,899	2,132	2,229	2,295	2,149	2,566
Change due to CX Ranch Mine as proposed	0	184	206	150	-13	-9	-3
Change due to CX Ranch 33-year mine plan	0	184	206	326	339	300	170
Change due to cumulative scenario	0	325	371	612	605	484	317
Rural residential							
Need without new mines in Decker area	3,563	3,529	3,980	4,003	4,174	4,201	4,161
Change due to CX Ranch Mine as proposed	0	130	152	107	-11	-8	-3
Change due to CX Ranch 33-year mine plan	0	131	152	240	250	251	115
Change due to cumulative scenario	0	254	303	464	477	440	217
Commercial							
Need without new mines in Decker area	118	122	146	154	168	162	204
Change due to CX Ranch Mine as proposed	0	15	8	1	1	1	1
Change due to CX Ranch 33-year mine plan	0	15	8	14	18	13	8
Change due to cumulative scenario	0	22	16	26	22	23	2

Source: MWR-N. 1983, p. 4-51; and MWR-N. 1985, pp. 35–38.

Note: The figures in the table are derived from population figures. As a result, some totals decrease between 2010 and 2015, reflecting the population decline at mine closure. For the proposed mine, some figures are negative because the population falls below the level expected with no new mines.

acres in the cumulative scenario (table 3-20). Increases in commercial acreage would be concentrated in urban areas, mostly near Sheridan (MWR-N, 1983, p. 4-50).

BIG HORN COUNTY

Because the CX Ranch Mine would not significantly affect the population of the county, little change in the land use pattern would occur outside the minesite (table 3-21).

INDIAN RESERVATIONS

The CX Ranch mine would not significantly affect land use patterns on either the Crow or Northern Cheyenne Indian Reservations.

TRANSPORTATION NETWORKS AND TRAFFIC FLOW

Summary of Impacts: The location of the access points to the proposed mine would provide a shorter view of oncoming traffic than that recommended by accepted highway design standards. Relocating the access points would mitigate this problem.

A related effect of increased coal production would be more unit coal trains passing through the region. The greatest impact, particularly in the cumulative scenario, would be increased delays at the Fifth Street crossing in Sheridan. Another effect would be increased traffic on Wyoming 338 and FAS 314. The accident rate (number of accidents per million vehicle miles), however, is not expected to change.

ROADS AND HIGHWAYS

Sheridan County

At full production, the CX Ranch Mine as proposed (12-year plan) would increase commuter traffic on Wyoming 338 by about 455 one-way trips per day (Montana Department of Highways [MDOH], April 18, 1983, p. 1). The 33-year mine would increase traffic by about 880 trips per day and the cumulative scenario by more than 1,300 trips per day. Including additional truck trips, total cumulative scenario traffic would be more than 2.5 times greater than traffic in 1981. Assuming the accident rate remains unchanged, the number of accidents would increase by 33 per year in the cumulative scenario compared to 13 per year with no new mines. Additional accidents would cause more injuries and perhaps some deaths.

Traffic congestion today in downtown Sheridan could be aggravated by additional commuter traffic. Where new mine workers choose to live would determine the degree of additional congestion. Since the miners' choice of residence is not possible to forecast, more accurate projections of traffic problems are not possible.

Increases in traffic would increase the maintenance costs to the county. It is impossible to predict a percentage increase in costs, but normal maintenance, such as pavement patching, snow removal, and guard rail repair, would go up (MDOH, April 18, 1983, p.2).

Roads and highways in the county other than Wyoming 338 could experience some increase in traffic, but the impact would be comparatively small (MDOH, April 8, 1983, pp. 1–2).

Big Horn County

FAS 314, the continuation of Wyoming 338, would have the same increases in traffic as Wyoming 338. Fluctua-

TABLE 3-21

Land Needed in Big Horn County, 1985-2015
(In Acres, Excluding Reservation Land)

Type of Land	1985	1990	1995	2000	2005	2010	2015
Urban residential							
Need without new mines in Decker area	279	299	321	344	357	376	397
Change due to CX Ranch Mine as proposed	0	6	6	2	0	0	0
Change due to CX Ranch 33-year mine plan	0	6	6	10	10	10	5
Change due to cumulative scenario	0	5	5	10	10	10	5
Rural residential							
Need without new mines in Decker area	1,006	1,070	1,121	1,164	1,206	1,287	1,410
Change due to CX ranch Mine as proposed	0	22	25	15	22	– 10[1]	– 68[1]
Change due to CX Ranch 33-year mine plan	0	22	25	40	38	22	– 54[1]
Change due to cumulative scenario	2	58	65	91	89	62	– 26[1]
Commercial							
Need without new mines in Decker area	39	43	47	52	56	59	67
Change due to CX Ranch Mine as proposed	0	1	0	0	0	3	0
Change due to CX Ranch 33-year mine plan	0	1	0	1	1	3	1
Change due to cumulative scenario	0	4	4	6	7	9	2

Source: MWR-N, 1983, p. 4-47.

[1] The negative figures, derived from population figures, result from miner families leaving the Decker area and thus reducing the need for residential land. The land, once converted from agriculture to residential, would probably remain as residential land.

tions in traffic would parallel fluctuations in employment. Traffic would be heaviest during shift changes, particularly if CX Ranch Mine shifts coincide with shifts at other nearby mines. Traffic increases would increase accidents and county road maintenance.

In the cumulative scenario, it is assumed that the opening of a mine on Youngs Creek on the Crow Indian Reservation would be accompanied by the construction of a new road between Lodge Grass and the minesite. This new road might slightly reduce the amount of traffic on Wyoming 338 if it were to handle some of the new mine-employee traffic from the Crow Indian Reservation that would otherwise have traveled to the CX Ranch Mine via I-90, Wyoming 338, and FAS 314.

Other roads and highways in the county could have some increases in traffic, but the impact would be comparatively small.

The main access to the CX Ranch Mine (fig. 3-7), would have a shorter view to the north than recommended by accepted highway design standards. The "sight distance" would be limited by a curve to about 850 feet. The accepted standard is 1,230 feet (MDOH, April 8, 1983, p. 4). The proposed access to the loadout facility would have the same sight distance problem.

No other problems with the mine roads would exist. The support structures for the conveyor over FAS 314 would stand at least 30 feet away from the highway and the conveyor would pass at least 20 feet above the highway. The conveyor structure would not create any problems with highway traffic (MDOH, April 8, 1983, p. 5).

RAIL NETWORK

As proposed, the CX Ranch Mine would increase the number of unit trains leaving the Decker area by an average of 15 one way trips per week (increasing total train trips, counting returning unloaded trains, by 30 per week). This number would double to 30 in the 33-year mine plan and rise to 54 (108 total) in the cumulative scenario. The primary resulting impact would be traffic delays at railroad crossings without grade separations (overpasses).

A unit train takes approximately four minutes to clear a crossing in urban areas, and one to two minutes in rural areas, where trains travel faster. The delays caused by trains would inconvenience motorists and delay emergency vehicles.

Where the increased coal production would go is not known, but most would probably be shipped out of the region by traveling first through Sheridan and then Big Horn County, rather than traveling first through Sheridan County and then south. As a result, especially in the cumulative scenario, Sheridan, Wyola, Lodge Grass, and other nearby communities would experience a significant increase in coal train traffic and could expect an increase in vehicle delays. Because the vehicle volumes are greatest in Sheridan, the vehicle delay problem would be greatest there (MWR-N, 1983, p. 4-38).

In particular, the train traffic at the Sheridan Fifth Street crossing could cause substantially increased delays and vehicle accidents. These problems are documented in an engineering feasibility study for an underpass at the crossing (ARIX, 1982, p. 29). The study used traffic volumes similar to those expected in the cumulative scenario. The report concluded that the benefit from separating train and vehicle traffic by an underpass (which would eliminate most problems) would outweigh the cost of the underpass by more than 20 percent. (ARIX, 1982, p. 4).

Communities on the railroad line beyond Big Horn and Sheridan Counties would also suffer delays. The amount of overall delay in any community would depend on the traffic volume at the crossing and the availability of nearby over- and underpasses (MWR-N, 1983, p. 4-38).

MITIGATING MEASURES

- To improve the view of oncoming traffic, the company could relocate the access roads for better sight distance.

OUTDOOR RECREATION

Summary of Impacts: Neither the CX Ranch Mine nor the development projected in the cumulative scenario would significantly affect recreation in the region. Specific popular sites, on the other hand, may become overcrowded and overused.

RECREATION USE INCREASES

Even without any new mine development, recreation use will steadily increase. (See chapter 2.) With the development of the CX Ranch Mine, use of regional outdoor recreational lands and facilities, as measured in recreation days, would increase slightly more. (One recreation day is 12 hours of use by one person.) In Big Horn County, the CX Ranch Mine proposed 12-year and 33-year plans would raise total recreation days about one percent over the level expected without any new mines. In Sheridan County, the comparable increase would reach 9 percent for the proposed 12-year plan and 14 percent for the 33-year plan (Mountain West Research-North [MWR-N], 1983, p. 8-13, 8-14). These increases would not degrade regional recreation, but might create periodic overuse or crowding at some popular sites. At sites now near overuse, the increases would create additional management problems.

Under the cumulative scenario, use increases would be similar. Recreation days in Big Horn County would increase 2 percent over the level forecast without any new mines. The increase in Sheridan County would peak at 25 percent around the year 2000. Regional recreation would not be degraded by these increases, but, again, popular sites, especially those near Sheridan, may become crowded and overused (MWR-N, 1983, pp. 8-13, 8-14).

MITIGATING MEASURES

- No company-sponsored mitigation programs would be needed as a result of either the CX Ranch Mine or cumulative scenario development. Governmental agencies can be expected to adjust plans for recreational units based upon mining and other development. Companies should cooperate with these agencies by providing information about plans and work-force characteristics.

CULTURAL RESOURCES

Summary of Impacts: Mining would damage or destroy six prehistoric cultural resource sites potentially eligible for the National Register of Historic Places. In addition, nine prehistoric and three historic potentially-eligible sites in the buffer zone may be indirectly affected by mining, collecting, vandalism, or blasting.

Mining would damage or destroy six prehistoric (24BH1001, -1030, -1944, -1949, -1950, -2091) cultural sites that lie in the permit area (the 12-year plan) and are potentially eligible for the National Register of Historic Places.

Sites in the buffer zone (a one-mile-wide band around the permit area, part of which has been intensively surveyed and part not) are less likely to be damaged directly by mining. Instead, most prehistoric sites may be damaged by collecting or vandalism. Petroglyphs may, in addition, be damaged by blasting. Nine prehistoric and three historic sites that lie in the buffer zone are potentially eligible for the National Register (chapter 2, table 2-16).

One potentially eligible prehistoric site (24BH1975) in the buffer zone would also lie in the Wolf Mountain Mine permit area. In addition, one potentially eligible historic site (24BH2123) located in the CX Ranch buffer zone is very close to the Wolf Mountain permit area. These sites may also be indirectly affected by the Wolf Mountain operation.

THE COMPANY'S PLANS

Plans have been submitted by Consol to mitigate destruction of the six prehistoric sites located within the 12-year permit area. A plan has also been submitted for the Squirrel Creek School (24BH2123), located in the intensively surveyed portion of the buffer zone. Mitigation plans for prehistoric sites consist of controlled excavation, surface collection, and precision recording. The Squirrel Creek School mitigation plan calls for relocating the school house. These mitigation plans are being reviewed by the State Historic Preservation Office and Office of Surface Mining; the plans and any required revisions would be implemented before mining begins.

The potentially eligible sites within the buffer zone that may be affected indirectly by mining do not require a detailed mitigation plan. However, to assure that no information is lost during mining, the company is legally required to—

- Take no action that would accelerate the natural deterioration of sites.
- Monitor site conditions.

Each mitigation step must be coordinated with the State Historic Preservation Office to assure adequate completion.

AESTHETICS

Summary of Impacts: Aesthetic impacts at the CX Ranch Mine would not be significant after reclamation. Although the postmining landscape would have gentler topography with fewer sandstone outcrops and sharp breaks, the landscape would not, after several decades, contrast greatly with unmined lands.

AESTHETICS DURING MINING

According to Consol's 12-year mine plan, the operation would destroy the vegetation and topography on a large part of the 1,905-acre permit area. If the company extends the mine life to 33 years, the operation would disturb at least 2,000 more acres. At the start of mining, the minesite would shift from a quiet ranching landscape typical of southeastern Montana to a busy industrial complex. The sounds of drilling, blasting, mine machinery, and the railroad would replace quiet. Mine equipment, support facilities, coal-processing facilities, the railroad loop, spoil piles, and haul roads would replace undisturbed rangeland.

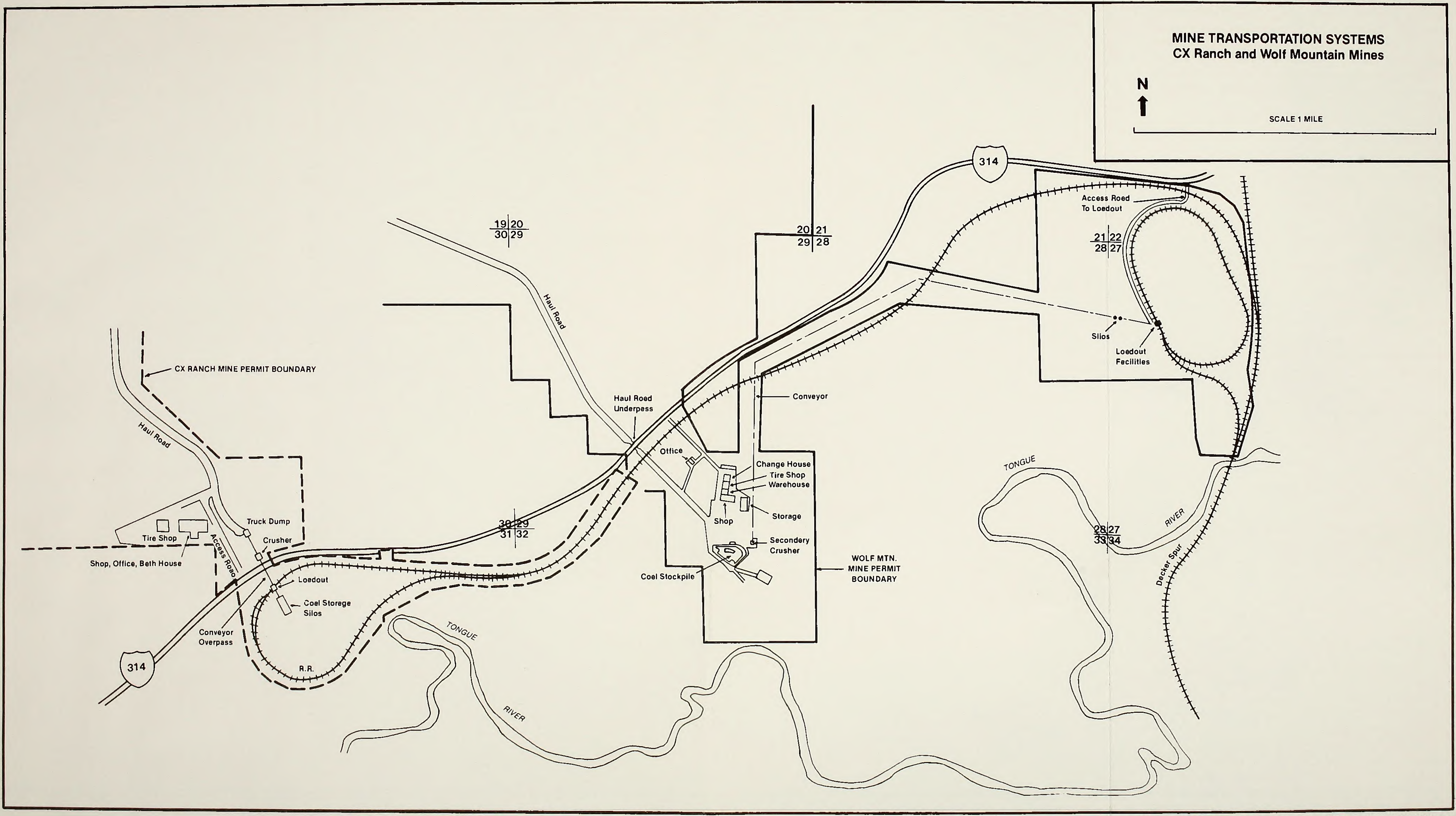


FIGURE 3-7 Construction of both the CX Ranch and Wolf Mountain Mines would require a complex transportation network. As proposed, the main access to the CX Ranch Mine would have a shorter-than-recommended sight distance along the highway to the northeast. Note that both operations straddle the highway.

The lines and forms of the mined land and overburden stockpiles would resemble the bluffs and breaks of surrounding unmined land. The color and texture of the unearthed overburden, mine pit, and coal beds, however, would contrast with the vegetation and surface texture of nearby undisturbed lands. The buildings in the facilities area, especially the coal storage silos, would contrast with the surrounding rangeland and the pattern of small scattered ranch buildings typical of this part of the West.

The mine would be obvious to highway travelers. The operation (in the 33-year plan) would be visible from about four miles of the Decker highway (FAS 314). For over two miles, the highway would pass within 2,000 feet of the mine operation. The highway would actually pass through the permit area in the facilities area.

Because much of the highway traffic would come from the Spring Creek and Decker Mines, the CX operation would appear normal to many travelers. Some traffic, however, would be recreational—primarily Tongue River and Reservoir users. To these recreationists, a mined landscape might be unpleasant. Still, views of the CX Ranch would resemble those at other nearby mines. The operation would add little to the overall visual impact of mining in the region. Moreover, more pleasing scenery is abundant nearby, providing recreationists ample views of undisturbed ranching landscapes.

AESTHETICS AFTER RECLAMATION

The postmining landscape would resemble the premining landscape. Eliminated would be the sandstone formations, the complex topographic pattern caused by erosion, the sharp breaks, and the variety of banded colors provided by eroded soil layers. A uniform, gently rolling topography would remain.

Initially, the postmining vegetation would be less diverse than that existing prior to mining. Shrubs, such as sagebrush, and patches of juniper and ponderosa pine trees would be lacking. Yet, over the long term, vegetation would closely match today's composition.

Although the postmining landscape would be less diverse and less appealing, the aesthetic impact would be minor. No scenery of local, regional, or national significance would be lost. With the gradual establishment of natural trees and shrubs, the minesite would contrast less and less with unmined lands. In the long term, the casual observer would not be aware of the reclaimed lands.

CUMULATIVE IMPACTS

If Kiewit Mining and Engineering opens the Wolf Mountain Mine, the short-term aesthetic impacts would be severe: The sights and sounds of mining would cover more land and be more intrusive. But the long-term aesthetic impacts would be about the same: Within several decades after reclamation, the impact of neither mine would be evident to the casual observer.

IRREVERSIBLE AND IRRETRIEVABLE COMMITMENTS OF RESOURCES

Consolidation Coal Company would mine 46.9 million tons of coal over 12 years (or, in the 33-year plan, 332 millions tons over 33 years); 3.5 million tons (or, in the 33-year plan, 23.2 million tons) would be lost to spillage, regulatory constraints, and limits on coal-extraction technology.

About 7.1 million gallons of diesel fuel, 72,000 gallons of gasoline, and 51 million kilowatt-hours of electricity would be used at the mine each year in the proposed 12-year plan. In the 33-year plan, these figures would rise to 10.2 million gallons of diesel fuel, 103,000 gallons of gasoline, and 86 million kilowatt-hours of electricity.

The mine would use an average of roughly 418 acre-feet of water per year in the proposed 12-year plan (or 718 acre-feet per year in the 33-year plan). A majority of this water would be lost to evaporation and therefore would not be available for other uses downstream, such as agriculture. The population associated with the mine would require an average of about 560 acre-feet per year (880 acre-feet in the 33-year plan).

The stratigraphy within the mine today would be permanently altered. The Anderson-Dietz and Canyon coal seams would be removed. Because the strata are neither unique nor valuable, except for the coal, this loss would not be significant.

Shallow ground water within and downgradient of the mine would contain about 50 percent more dissolved solids than before mining. Consol proposes to replace degraded wells with deeper wells. The loss would be insignificant, and the land, after mining, could be used by wildlife and livestock.

Six prehistoric sites, all eligible for the National Register of Historic Places, would be destroyed by proposed (12-year) mining. But the information from the six would not be lost: The sites would all be inventoried and recorded before removal.

Fourteen more sites, 12 prehistoric and 2 historic, would also be destroyed by mining. None are eligible for the National Register.

Twelve additional sites may suffer loss of information from collecting, vandalism, and blasting. These sites lie in the buffer zone (just outside the 12-year permit area) and include 9 prehistoric and 3 historic sites.

Three raptor nests would be removed by proposed (12-year) mining. One more nest may be abandoned due to mining activities. A small part of pronghorn and sage grouse wintering areas would be lost for several decades, but would be restored after reclamation. An additional raptor nest may be abandoned due to life-of-mine operations.

The topography of the minesite would change during mining, but the final topography would be about the same as today. Similarly, the landscape would change from pastoral to industrial during mining, but would largely return to today's condition within several decades after mining.

During mining, the 974 acres disturbed (2,874 in the 33-year plan) would not be available for grazing or other agricultural uses. The potential loss of cattle production would amount to about 90 head (240 in the 33-year plan).

SHORT-TERM USES VERSUS LONG-TERM PRODUCTIVITY OF THE LANDS AFFECTED BY MINING

Coal from the CX Ranch Mine would produce electricity and considerable tax revenues, royalties, and jobs. These benefits would be gained at a cost of short-term vegetative, wildlife, and livestock productivity at the minesite.

The number of nesting raptors would probably be reduced after mining. Populations of some wildlife species on reclaimed lands would take decades to recover.

Air pollutant concentrations, especially total suspended particulates, would increase during mining. Once mining and reclamation are completed, the pollutant concentrations would return to premining levels.

The water quality of Squirrel Creek would be degraded during mining. After mining and reclamation are completed, today's water quality would be restored.

Reductions in long-term vegetative productivity would be minimal or nonexistent. For the short-term, the maximum *potential* vegetative productivity of the reclaimed lands would probably not be as high after mining as what could have been achieved prior to mining under optimum management. The slight reduction that could occur could last for several years, caused by unavoidable impacts on soils. Soil impacts would include disruption of natural soil profile and pore continuity, reduction of infiltration rates and organic matter concentrations, and loss of structure and microorganism populations. On steep slopes (over 18 degrees), reclamation would be more difficult than elsewhere. The steepness may cause long-term erosion.

In the short term, the mine would increase the cost of Sheridan County government by about $18.2 million ($32.1 million in the 33-year plan). Meanwhile, the mine would pay $158 million in taxes ($1,116 million in the 33-year plan), but none would go to Sheridan County.

APPENDIXES

APPENDIX A

The Decker Area Mines Comprehensive Social Sciences Study

The Department of State Lands and the U.S. Office of Surface Mining hired a consultant to analyze the socioeconomic impacts that could result from opening three new mines—CX Ranch, Wolf Mountain, and Youngs Creek. Mountain West Research-North, Inc., the consultant hired, produced a comprehensive social sciences study describing past and present conditions and forecasting these conditions for the future in Big Horn County, Montana, and Sheridan County, Wyoming. The report also covered the Northern Cheyenne and Crow Indian Reservations.

Included in the report are discussions of a wide range of topics, each analyzed under four "scenarios." The report first gives an analysis of future socioeconomic conditions if none of the three proposed mines are built. This is called the baseline scenario. Following this are three mine development scenarios: the CX Ranch Mine as proposed, the 33-year CX Ranch Mine, and all three mines.

Copies of the report are available for public review in the Big Horn County and Sheridan County libraries and through the interlibrary loan system from the Montana and Wyoming State libraries.

DEFINITION OF STUDY AREAS

Mountain West subdivided the larger area studied. The subdivisions, or subcounty study areas, were based on the locations of the proposed mines, the composition of local labor markets, commuting patterns, and trading relationships among communities. The subcounty areas were geographically defined to conform, as closely as possible, to governmental and planning jurisdictions that could be affected by the proposed mines.

TOPICS AND METHODOLOGIES IN THE SOCIAL SCIENCES STUDY

Economic and Demographic

Forecasts of population, employment, and income were prepared for each subcounty area and jurisdiction for all scenarios. The forecasts were produced by a computerized model developed by Mountain West Research called "Planning and Assessment System" (PAS). The model, adapted to the study area, gave forecasts used to identify significantly affected areas. Those areas in which little effect was forecast were dropped from the detailed impact evaluation process.

Social Life and Cultural Diversity

The approach used for social life and cultural diversity blended field observation, interviews, community surveying, secondary data analysis, and historical research. The Guide to Social Assessment (BLM, 1982) served to organize the analysis. This was the first time the Guide was used for a mine plan in the Powder River Basin, and the Department of State Lands, Environmental Analysis Bureau, would appreciate comments on its effectiveness.

The basic assessment of social conditions was enhanced by studies of the following:

- Social history. Sheridan County, Big Horn County, the Crow Reservation, and the Northern Cheyenne Reservation were covered.
- Mine workers. This study developed a worker profile.
- Area residents in Big Horn and Sheridan Counties. Mountain West obtained information about attitudes, perceptions, social networks, and employment and demographic characteristics.
- Communities. This study delineated the response of various communities to energy development.
- Crow Reservation residents. The Crow Tribe of Indians produced this study.

Housing

A housing demand and supply forecast was prepared for each subcounty area and scenario. The forecasts were based on the demographic forecasts.

Facilities and Services

A complete range of community facilities and services was examined for each scenario. The jurisdictions analyzed included two counties, the Crow Reservation, the Northern Cheyenne Reservation, five incorporated cities, five unincorporated places, three public high school and seven public elementary districts in Big Horn County, and two school districts in Sheridan County.

Fiscal

For each facility or service, detailed revenues and expenditures for each scenario were projected for affected jurisdictions. State and Federal government revenues that would result from the proposed mines were also projected.

Transportation

Traffic on area roads and the rail system was projected for each scenario. The analysis included safety, capacity, and maintenance cost.

Outdoor Recreation

Average and short-term peak use of regional recreation sites was estimated for each scenario. The use was compared to the capacity of the recreational areas.

Land Use

Acreage needs by land use were projected for each scenario and compared to the land availability. The impacts of the proposed mines on land values were examined, as were land use changes on the proposed minesites.

SPECIAL REPORTS

In addition to the multi-volume social sciences study, Mountain West submitted twelve separate reports documenting the results of individual research efforts. The reports include—

- A historical overview of Big Horn and Sheridan counties.
- The Big Horn and Decker Mine Worker Survey.
- A survey of Hardin, Decker, and Sheridan area residents.
- A study of the effects of the end of coal mining.
- Land value effects of the proposed mines.
- An update on satisfaction, community change, and coal development in Decker, Montana.
- Mining impacts on the wage rates in other employment sectors.
- The effects of energy development on the cost of living and inflation.
- Distribution of local purchases by the Decker area mines.
- The effects of mining operations on the agricultural production of the CX Ranch.
- A generic mitigation program for social and economic impacts.
- The State, interstate, and Federal mitigation authorities.

APPENDIX B
Socioeconomic Tables

TABLE B-1
Big Horn County Population

Area	1970	1980	Percent Change
Montana	694,409	786,690	13.3
Male	347,005	392,625	13.1
Female	347,404	394,065	13.4
Big Horn County	10,057	11,096	10.3
Male	4,990	5,480	9.8
Female	5,067	5,616	10.8
Hardin City	2,733	3,300	20.7
Big Horn County North	110	949	762.7
Decker Area	245	189	-22.9

Source: U.S. Department of Commerce, Bureau of the Census, 1970 Census of the Population: Characteristics of the Population, Montana, tables 19, 20, 34, 35, 36, 49, 50; U.S. Department of Commerce, Bureau of the Census, 1980 Census of the Population: Characteristics of the Population, Montana, tables 19, 20, 46.
Note: These figures do not reflect the undercount of Crow Indians in the 1980 U.S. Census.

TABLE B-2

Big Horn County Population by Age and Race, 1970 and 1980

Population Characteristics	1970			1980		
	Big Horn County		Montana	Big Horn County		Montana
	Number	Percent	Percent	Number	Percent	Percent
Age distribution						
Under 5	1,104	11.0	8.3	1,184	10.7	8.2
5-9	1,273	12.7	10.6	1,066	9.6	7.7
10-14	1,193	11.9	11.2	1,044	9.4	7.9
15-19	985	9.8	10.2	1,164	10.5	9.5
20-24	697	6.9	7.3	954	8.6	9.4
25-29	656	6.5	6.1	968	8.7	9.1
30-34	577	5.7	5.5	860	7.7	7.8
35-39	514	5.1	5.2	664	6.0	6.1
40-44	506	5.0	5.5	535	4.8	5.1
45-49	509	5.1	5.5	479	4.3	4.6
50-54	512	5.1	5.6	440	4.0	4.7
55-59	476	4.7	5.0	439	4.0	4.6
60-64	362	3.6	4.1	398	3.6	4.4
65+	693	6.9	9.9	901	8.1	10.7
Median age	23.4		27.1	25.7		29.0
Ethnic distribution						
White	6,018	59.8	95.7	5,781	52.1	94.1
Nonwhite	4,039	40.2	4.3	5,315	47.9	5.9
TOTAL POPULATION	10,057	100.0	100.0	11,096	100.0	100.0

Source: U.S. Department of Commerce, Bureau of the Census, 1970 Census of the Population: Characteristics of the Population, Montana, tables 19, 20, 34, 35, 49, 50; U.S. Department of Commerce, Bureau of the Census, 1980 Census of the Population: Characteristics of the Population, Montana, tables 19, 20, 46.

Note: These figures do not reflect the undercount of Crow Indians in the 1980 U.S. Census.

TABLE B-3

Forecast of Big Horn County Population With No New Mines

Year	Big Horn County[1]	Decker/ Spring Creek Area	Rest of County
1980	12,180	205	11,975
1981	12,235	201	12,034
1982	12,400	195	12,205
1983	12,496	183	12,313
1984	12,604	176	12,428
1985	12,746	170	12,576
1988	12,133	174	12,959
1989	13,254	175	13,079
1990	13,364	180	13,184
1995	14,249	200	14,049
2000	14,904	204	14,700
2001	15,044	202	14,842
2002	15,185	200	14,985
2005	15,608	197	15,411
2010	16,560	207	16,353
2015	17,770	217	17,553

Source: Mountain West Research-North, Inc., 1985.

TABLE B-4

Big Horn County Housing Units

Type of Unit	1970	1980[1]	Increase in Number of Units	Percent 1970-1980 Growth
Total housing units	2,900	3,867	967	33.3
Year-round units	2,866	3,719	853	29.8
Single-family detached	2,420	2,777	357	14.8
Multifamily	273	467	194	71.1
Mobile homes	173	475	302	174.6

Source: U.S. Department of Commerce, Bureau of the Census, Detailed Housing Characteristics for Montana, 1970, 1980.

[1] Not revised for 1980 census undercount.

TABLE B-5

Forecast of Big Horn County Housing Demand With No New Mines (Housing Units)

Year	Big Horn County	City of Hardin	Big Horn County North	Decker Area
1980	3,935	1,371	364	96
1981	3,996	1,375	365	97
1982	4,011	1,368	363	96
1983	4,070	1,374	364	95
1984	4,126	1,380	365	96
1985	4,189	1,393	366	97
1986	4,262	1,406	368	98
1987	4,326	1,417	369	99
1988	4,406	1,433	372	100
1989	4,466	1,443	372	100
1990	4,596	1,496	385	104
1995	4,974	1,607	401	109
2000	5,374	1,721	418	113
2005	5,632	1,784	432	109
2010	5,997	1,882	455	114
2015	6,481	1,985	476	120

Source: Mountain West Research-North, Inc., 1983.

Note: Figures revised to compensate for the 1980 census undercount.

TABLE B-6

1980 U.S. Census and Revised Population Counts

	1980 Census[1]		Revised Count[2]	
Place	Total Population	Crow Indian	Total Population	Crow Indian
Big Horn County	11,096	5,315	12,180	6,375
Crow Reservation	5,645	3,840	6,758	4,792
Crow Agency and Northeast area	2,100	1,696	2,564	2,144
Lodge Grass and Southeast area	2,136	1,438	2,647	1,827
Central area	937	343	958	362
West area	472	363	589	459

[1] Department of Commerce, U.S. Bureau of the Census, 1980 Census Preliminary Population and Housing Unit Counts, January, 1981.

[2] Mountain West Research-North, Inc., 1983.

TABLE B-7

Forecast of Crow Indian Population With No New Mines (Crow Reservation and Allocation Areas)

Year	Crow Reservation	Crow Agency and Northeast Area	Lodge Grass and Southeast Area	Central Area	West Area
1980	4,792	2,144	1,827	362	459
1981	4,895	2,189	1,865	371	470
1982	4,996	2,235	1,902	379	480
1983	5,102	2,282	1,941	388	491
1984	5,199	2,326	1,977	395	501
1985	5,300	2,371	2,015	403	511
1986	5,392	2,413	2,050	409	520
1987	5,486	2,456	2,085	416	529
1988	5,579	2,498	2,120	423	538
1989	5,669	2,539	2,155	429	546
1990	5,753	2,577	2,188	434	554
1995	6,162	2,763	2,350	459	590
2000	6,611	2,970	2,531	483	627
2005	6,992	3,143	2,671	471	707
2010	7,439	3,434	2,842	502	752
2015	8,116	3,648	3,100	547	821

Source: Mountain West Research-North, Inc., 1983.

Note: Figures revised to compensate for the 1980 census undercount.

TABLE B-8

Forecast of Non-Indian Population With No New Mines (Crow Reservation)

Year	Crow Reservation	Crow Agency and Northeast Area	Lodge Grass and Southeast Area	Central Area	West Area
1980	1,966	420	820	596	130
1981	1,966	419	818	600	129
1982	1,956	419	812	597	128
1983	1,948	419	807	596	126
1984	1,943	418	804	595	126
1985	1,941	418	801	597	125
1986	1,940	418	799	599	124
1987	1,939	418	794	601	123
1988	1,937	418	797	602	123
1989	1,933	417	791	603	122
1990	1,966	419	800	622	125
1995	1,972	418	793	636	125
2000	1,952	417	779	632	124
2005	2,034	459	788	656	131
2010	2,143	484	830	691	138
2015	2,245	507	869	724	145

Source: Mountain West Research-North, Inc., 1983.

Note: Figures revised to compensate for the 1980 census undercount.

TABLE B-9

Forecast of Housing Unit Demand/Supply With No New Mines (Crow Reservation, Crow Indian Population Only)

Year	Total Demand	Incremental Demand Over Previous Year	Local Supply Response (Limit = 40)	Cumulative (Deficit) Surplus
1980	1,117			
1981	1,150	33	33	0
1982	1,181	31	31	0
1983	1,223	42	40	(2)
1984	1,261	38	40	0
1985	1,294	33	33	0
1986	1,336	42	40	(2)
1987	1,371	35	37	0
1988	1,415	44	40	(4)
1989	1,451	36	40	0
1990	1,480	29	29	0
1995	1,645	165 for 5 years	33 per year	0
2000	1,833	188 for 5 years	38 per year	0
2005	1,936	103 for 5 years	21 per year	0
2010	2,060	124 for 5 years	25 per year	0
2015	2,247	187 for 5 years	37 per year	0

Source: Mountain West Research-North, Inc., 1983.

TABLE B-10

Sheridan County Population

Area	1970	1980	Percent Change
Wyoming	332,416	470,816	41.6
Sheridan County	17,852	25,048	40.3
Sheridan City	10,856	15,146	39.5
Ranchester	208	655	214.9
Dayton	396	701	77.0

Source: U.S. Department of Commerce, Bureau of the Census, Detailed Housing Characteristics for Wyoming, 1970, 1980.

TABLE B-11

Forecast of Sheridan County Population With No New Mines, 1980-2015

Year	Sheridan County	Sheridan City	Ranchester-Dayton Area	Rest of County
1980	25,048	15,139	1,841	8,068
1981	25,253	15,278	1,856	8,119
1982	24,992	15,120	1,837	8,035
1983	25,335	15,328	1,862	8,145
1984	25,153	15,218	1,849	8,086
1985	25,250	15,276	1,856	8,118
1988	26,410	15,978	1,941	8,491
1989	26,701	16,154	1,963	8,584
1990	26,970	16,317	1,982	8,671
1995	27,389	17,554	2,019	7,816
2000	29,650	18,087	2,203	9,360
2001	26,671	18,099	2,205	9,367
2002	29,691	18,112	2,206	9,373
2005	29,753	18,149	2,211	9,393
2010	31,321	19,016	2,306	9,999
2015	31,196	19,029	2,293	9,874

Source: Mountain West Research-North, Inc., 1985, pp. 35-37.

TABLE B-12

Sheridan County Housing Units, 1970 and 1980

	Sheridan County			City of Sheridan			Ranchester, Dayton and Area
Type of Unit	1970	1980	Percent 1970-1980 Growth	1970	1980	Percent 1970-1980 Growth	Number of 1980 Units
Total housing units	6,893	10,928	58.5	4,438	6,604	44.8	689
Year-round units	6,799	10,295	51.4	4,434	6,577	48.3	686
Single-family detached	5,528	6,934	25.4	3,454	4,318	25.0	447
Multifamily	1,023	2,138	109.0	924	1,733	87.6	96
Mobile homes	248	1,223	393.1	56	526	839.3	143

Source: U.S. Department of Commerce, Bureau of the Census, Detailed Housing Characteristics for Wyoming, 1970, 1980.

TABLE B-13

Forecast of Sheridan County Housing Demand With No New Mines (Housing Units)

Year	Sheridan County	Sheridan City	Greater Sheridan Area[1]	Ranchester-Dayton Area	Rest of County[2]
1980	10,457	6,689	1,602	686	1,480
1981	10,564	6,795	1,637	693	1,423
1982	10,469	6,738	1,629	689	1,397
1983	10,658	6,861	1,665	703	1,412
1984	10,629	6,843	1,667	703	1,401
1985	10,728	6,904	1,669	711	1,434
1988	10,613	6,790	1,637	690	1,507
1989	10,869	7,005	1,691	713	1,454
1990	11,850	7,655	1,840	780	1,569
1995	13,308	8,602	2,055	881	1,774
2000	13,815	9,011	2,134	919	1,743
2005	14,239	9,297	2,176	940	1,822
2010	15,010	9,800	2,294	982	1,935
2015	15,556	10,358	2,425	1,053	1,667

Source: Mountain West Research-North, Inc., 1983; 1985, pp. 35-37.

[1] Excluding the city of Sheridan.

[2] Numbers will not add to total due to rounding error.

TABLE B-14

Forecast of Northern Cheyenne Reservation Population With No New Mines

Year	Total Northern Cheyenne Population	Northern Cheyenne Population (Big Horn County)	Non-Indian Population (Big Horn County)
1980	3,255	822	196
1985	3,583	904	194
1990	3,960	1,000	198
1995	4,324	1,092	200
2000	4,670	1,180	200
2005	4,958	1,255	199
2010	5,262	1,358	197

Source: Mountain West Research-North, Inc., 1983.

TABLE B-15

Public Outdoor Recreation Areas of Regional and County Importance

Area	Ownership	Acres	Comments
Region			
Pryor Mountain Wild Horse Range	BLM-NPS		Borders Big Horn County
Bighorn National Forest	USFS	1,115,125	Segment in Sheridan County; 0.7 percent in other ownership
Bighorn Canyon National Recreation Area	NPS	120,284	Segment in Big Horn County; 43.3 percent in other ownership
Ashland Division of Custer National Forest	USFS	502,152	Borders Big Horn County; 13 percent in other ownership
Pryor Division of Custer National Forest	USFS		Borders Big Horn County
Big Horn County, Montana			
Arapooish Fishing Access Site	MDFWP		Deeded land along the Bighorn River within the boundaries of the Crow Reservation
Bighorn Fishing Access Site	MDFWP		Deeded land along the Bighorn River within the boundaries of the Crow Reservation
Two Leggins Fishing Access Site	MDFWP		Deeded land along the Bighorn River within the boundaries of the Crow Reservation
Grant Marsh Fishing Access Site	MDFWP	140	Access to Bighorn River 8 miles west of Hardin
Tongue River Reservoir	DNRC		Tongue River
Rosebud Battlefield	MDFWP	5,000	Historic Site with hunting in season
Custer Battlefield National Monument	NPS	755	Historic Site on Crow Reservation
Chief Plenty Coups State Monument	MDFWP	195	Historic Site on Crow Reservation
Scattered Parcels of Public Land	BLM	27,686	Generally Inaccessible
Sheridan County, Wyoming			
Kerns Wildlife Unit	WGF	9,147+	Managed for wildlife and big game hunting
Amsdey Wildlife Unit	WGF		
State Bird Farm	WGF	30	Managed for wildlife
State Fish Hatchery	WGF	5	Wildlife Management
Tongue River Canyon Camping Area	WGF		
Connor Battlefield	State of Wyoming		Historic site with interpretive facilities
Fetterman Fight Site	State of Wyoming		Historic site with interpretive facilities
Fort Phil Kearney	State of Wyoming		Historic site with interpretive facilities
Wagon Box Fight Site	State of Wyoming		Historic site with interpretive facilities
Scattered Parcels of Public Land	BLM	51,540	Generally Inaccessible

Sources: Montana Department of Fish and Game, Montana Statewide Comprehensive Outdoor Recreation Plan (SCORP), vol. 2., March, 1978; Bureau of Land Management, Public Information Office, 1982.

Note: BLM = Bureau of Land Management, NPS = National Park Service, USFS = U.S. Forest Service, MDFWP = Montana Department of Fish, Wildlife and Parks, DNRC = Montana Department of Natural Resources and Conservation, WGF = Wyoming Game and Fish Department.

TABLE B-16

Population Increases in Big Horn County from CX Ranch Mine and Cumulative Scenario

		Consol Impact Population		Cumulative Impact Population	
Year	Baseline[1] Population	Number	Percent Increase Over Baseline	Number	Percent Increase Over Baseline
1985	12,746	0	0	0	0
1988	13,133	0	0	0	0
1989	13,254	0	0	0	0
1990	13,364	62		113	0.1
1995	14,249	135	0.1	215	1.5
2000	14,904	169	1.1	337	2.3
2001	15,044	233	1.5	352	2.3
2005	15,608	216	1.4	358	2.3
2010	16,560	204	1.2	302	1.8
2015	17,770	188	1.1	216	1.2

Source: Mountain West Research-North, Inc., 1985, p. 38.

[1] With no new mines.

TABLE B-17

Sheridan County Population Increases from CX Ranch Mine and Cumulative Scenario

		CX Ranch Mine		Cumulative Scenario	
Year	Baseline[1] Population	Added Population	Percent Increase Over Baseline	Added Population	Percent Increase Over Baseline
1985	25,250	0	0	0	0
1988	26,410	200	0.1	200	0.1
1989	26,701	642	2.4	2,362	8.8
1990	26,970	2,509	9.3	4,326	16.0
1995	29,014	2,658	9.2	4,779	16.5
2000	29,650	3,221	10.9	7,340	24.8
2001	29.671	4,463	15.0	7,708	26.0
2005	29,753	4,475	15.0	7,861	26.4
2010	31,321	4,187	13.4	6,743	21.5
2015	31,196	3,328	10.7	5,083	16.3

Source: Mountain West Research-North, Inc. 1983.

[1] With no new mines.

APPENDIX C

Reclamation Seed Mixtures

TABLE C-1

Seed Mixtures and Planting Rates for Revegetation Units

Species	Seed Mixture (lbs PLS*/acre)	PLS*/ft^2
Revegetation Unit 1 - Improved Pasture		
Pubescent wheatgrass (*Agropyron trichophorum*)	13.3	20.0
Sainfoin (*Onobrychis* spp.)	11.7	4.6
Alfalfa (*Medicago sativa*)	1.0	4.5
Wintergraze	5.0	1.6
TOTAL	31.0	30.7
Revegetation Unit 2 - Drainageways**		
Initial Seeding		
Blue grama (*Bouteloua gracilis*)	1.0	5.6
Green needlegrass (*Stipa viridula*)	3.4	3.0
Yarrow (*Achillea millefolium*)	0.2	10.3
Lewis flax (*Linum lewisii*)	0.2	1.2
Cicer milkvetch (*Astragalus cicer*)	0.3	0.4
Purple prairie clover (*Petalostemon purpureum*)	0.3	1.3
White prairie clover (*Petalostemon candidum*)	0.2	1.0
Sainfoin (*Onobrychis* spp.)	1.0	0.4
Blanket flower (*Gailardia aristata*)	0.3	1.0
Globemallow (*Sphaeralcea coccinea*)	0.1	1.0
Winterfat (*Ceratoides lanata*)	0.7	1.0
Nuttal saltbush (*Atriplex nuttallii*)	0.5	0.2
Silver sagebrush (*Artemisia cana*)	0.5	7.9
Greasewood (*Sarcobatus vermiculatus*)	1.0	3.1
Wintergraze	5.0	1.6
TOTAL	14.7	39.0
Second Seeding		
Western wheatgrass (*Agropyron smithii*)	3.0	5.0
Thickspike wheatgrass (*Agropyron dasystachyum*)	1.5	4.0
Big bluegrass (*Poa ampla*)	1.1	9.0
Basin wildrye (*Elymus cinereus*)	4.8	6.0
TOTAL	10.4	24.0
Revegetation Unit 3 - Sagebrush/Grassland**		
Initial Seeding		
Blue grama (*Bouteloua gracilis*)	1.0	5.6
Green needlegrass (*Stipa viridula*)	3.4	3.0
Indian ricegrass (*Oryzopsis hymenoides*)	5.3	2.0
Yarrow (*Achillea millefolium*)	0.2	10.3
Lewis flax (*Linum lewisii*)	0.2	1.2
Cicer milkvetch (*Astragalus cicer*)	0.3	0.4
Purple prairie clover (*Petalostemon purpureum*)	0.3	1.3
White prairie clover (*Petalostemon candidum*)	0.2	1.0
Sainfoin (*Onobrychis* spp.)	1.0	0.4
Blanket flower (*Gaillardia aristata*)	0.3	1.0
Globemallow (*Sphaeralcea coccinea*)	0.1	1.0

Species	Seed Mixture (lbs PLS*/acre)	PLS*/ft^2
Revegetation Unit 3 (continued)		
Winterfat (Ceratoides lanata)	0.7	1.0
Nuttal saltbush (Atriplex nuttallii)	0.5	0.2
Big sagebrush (Artemisia tridentata)	0.5	12.2
Wintergraze	5.0	1.6
TOTAL	19.0	42.2
Second Seeding		
Beardless bluebunch wheatgrass (Agropyron inerme)	5.0	13.2
Western wheatgrass (Agropyron smithii)	2.3	4.0
Thickspike wheatgrass (Agropyron dasystachyum)	1.2	3.1
Needle-and-thread (Stipa comata)	3.5	2.0
TOTAL	12.0	22.3
Revegetation Unit 4 - Sod-forming Grassland**		
Initial Seeding		
Prairie sandreed (Calmovilfa longifolia)	2.5	10.0
Sideoats grama (Bouteloua curtipendula)	5.2	5.1
Little bluestem (Schizachyrium scoparius)	3.8	5.0
Blue grama (Bouteloua gracilis)	2.0	11.2
Green needlegrass (Stipa viridula)	3.4	3.0
Indian ricegrass (Oryzopsis hymenoides)	3.0	1.1
Yarrow (Achillea millefolium)	0.2	10.3
Lewis flax (Linum lewisii)	0.2	1.2
Cicer milkvetch (Astragalus cicer)	0.3	0.4
Purple prairie clover (Petalostemon purpureum)	0.3	1.3
White prairie clover (Petalostemon candidum)	0.2	1.0
Sainfoin (Onobrychis spp.)	1.0	0.4
Blanket flower (Gaillardia aristata)	0.3	1.0
Globemallow (Sphaeralcea coccinea)	0.1	1.0
Winterfat (Ceratoides lanata)	0.7	1.0
Nuttal saltbush (Atriplex nuttallii)	0.5	0.2
Wintergraze	5.0	1.6
TOTAL	28.7	54.8
Second Seeding		
Thickspike wheatgrass (Agropyron dasystachyum)	0.6	1.6
Western wheatgrass (Agropyron smithii)	1.2	2.0
Needle-and-thread (Stipa comata)	5.3	3.0
TOTAL	7.1	6.6
Revegetation Unit 5 - Conifer/Mixed Shrubs**		
Initial Seeding		
Blue grama (Bouteloua gracilis)	1.0	5.6
Green needlegrass (Stipa viridula)	3.4	3.0
Indian ricegrass (Oryzopsis hymenoides)	3.0	1.1
Yarrow (Achillea millefolium)	0.2	10.3

Species	Seed Mixture (lbs PLS*/acre)	PLS*/ft^2
Revegetation Unit 5 (continued)		
Lewis flax (*Linum lewisii*)	0.2	1.2
Cicer milkvetch (*Astragalus cicer*)	0.3	0.4
Purple prairie clover (*Petalostemon purpureum*)	0.3	1.3
White prairie clover (*Petalostemon candidum*)	0.2	1.0
Sainfoin (*Onobrychis* spp.)	1.0	0.4
Blanket flower (*Gaillardia aristata*)	0.3	1.0
Globemallow (*Sphaeralcea coccinea*)	0.1	1.0
Winterfat (*Ceratoides lanata*)	0.7	1.0
Nuttal saltbush (*Atriplex nuttallii*)	0.5	0.2
Greasewood (*Sarcobatus vermiculatus*)	1.0	3.1
Big sagebrush (*Artemisia tridentata*)	0.2	4.0
Wintergraze	5.0	1.6
TOTAL	17.4	36.2
Ponderosa pine (*Pinus ponderosa*)	**	**
Rocky Mountain juniper (*Juniperus scopulorum*)	**	**
Second Seeding		
Bluebunch wheatgrass (*Agropyron spicatum*)	6.5	17.2
Thickspike wheatgrass (*Agropyron dasystachyum*)	1.2	3.1
Indian ricegrass (*Oryzopsis hymenoides*)	3.0	1.1
Needle-and-thread (*Stipa comata*)	3.5	2.0
TOTAL	14.2	23.4
Revegetation Unit 6 - Ridgetop Grassland		
Initial Seeding		
Blue grama (*Bouteloua gracilis*)	1.0	5.6
Green needlegrass (*Stipa viridula*)	3.4	3.0
Indian ricegrass (*Oryzopsis hymenoides*)	5.3	2.0
Yarrow (*Achillea millefolium*)	0.2	10.3
Lewis flax (*Linum lewisii*)	0.2	1.2
Cicer milkvetch (*Astragalus cicer*)	0.3	0.4
Purple prairie clover (*Petalostemon purpureum*)	0.3	1.3
White prairie clover (*Petalostemon candidum*)	0.2	1.0
Sainfoin (*Onobrychis* spp.)	1.0	0.4
Blanket flower (*Gaillardia aristata*)	0.3	1.0
Globemallow (*Sphaeralcea coccinea*)	0.1	1.0
Winterfat (*Ceratoides lanata*)	0.7	1.0
Nuttal saltbush (*Atriplex nuttallii*)	0.5	0.2
Wintergraze	5.0	1.6
TOTAL	18.5	30.0
Second Seeding		
Bluebunch wheatgrass (*Agropyron spicatum*)	7.0	18.5
Thickspike wheatgrass (*Agropyron dasystachyum*)	0.5	1.3
Indian ricegrass (*Oryzopsis hymenoides*)	8.0	3.0
Needle-and-thread (*Stipa comata*)	3.0	1.7
TOTAL	18.5	24.5

Species	Seed Mixture (lbs PLS*/acre)	PLS*/ft^2
Steep Slope Revegetation Unit***		
Streambank wheatgrass (*Agropyron riparium*)	1.4	4.5
Thickspike wheatgrass (*Agropyron dasystachyum*)	2.5	6.5
Beardless bluebunch wheatgrass (*Agropyron inerme*)	2.0	5.3
Indian ricegrass (*Oryzopsis hymenoides*)	5.3	2.0
Green needlegrass (*Stipa viridula*)	5.0	4.4
Needle-and-thread (*Stipa comata*)	2.0	1.1
Sideoats grama (*Bouteloua curtipendula*)	7.3	7.2
Yarrow (*Achillea millefolium*)	0.2	10.3
Lewis flax (*Linum lewisii*)	0.2	1.2
Cicer milkvetch (*Astragalus cicer*)	0.3	0.4
Purple prairie clover (*Petalostemon purpureum*)	0.3	1.3
White prairie clover (*Petalostemon candidum*)	0.2	1.0
Sainfoin (*Onobrychis* spp.)	1.0	0.4
Blanket flower (*Gaillardia aristata*)	0.3	1.0
Globemallow (*Sphaeralcea coccinea*)	0.1	1.0
Winterfat (*Certoides lanata*)	0.7	1.0
Big sagebrush (*Artemisia tridentata*)	1.2	14.6
TOTAL	30.0	63.2

Source: Consolidation Coal Company, 1981, vol. 4.

*PLS (pure live seed) = % germination x % purity.

**Container-grown shrub seedlings would be planted between the initial and second range seeding to offset seeding failures and to provide quick establishment of shrubs. Tree seedlings would also be planted at this time. Ponderosa pine and Rocky Mountain juniper would not be seeded; container-grown stock would be planted at 100 percent of premining densities.

***For the steep-slope revegetation unit, wintergraze or another similar annual cover crop would be seeded concurrently at 5 pounds per acre. Also, containerized tree and shrub seedlings would be hand planted during the third spring following seeding. Stocking rates would be based on 100 percent of each species' premining densities.

APPENDIX D
Water Quality Tables

TABLE D-1

Predicted Nitrogen Concentrations if Consol Discharges Water To Squirrel Creek During Low Flow

	Squirrel Creek Above Mine		Mine Discharge		Squirrel Creek Below Mine
	Flow[1] (cfs)	Concentrations[2] (mg/l)	Flow[3] (cfs)	Concentrations[4] (mg/l)	Concentrations[5] (mg/l)
Total ammonia nitrogen					
Mean	3.0	0.3	0.6	1.5	0.6
	1.6	0.3	0.6	1.5	0.7
	0.13	0.3	0.6	1.5	1.3
Extreme Case	3.0	1.6	1.1	3.5	1.9
	1.6	1.6	1.1	3.5	2.4
	0.13	1.6	1.1	3.5	3.3
Total nitrate nitrogen					
Mean	3.0	0.2	0.6	3.5	0.8
	1.6	0.2	0.6	3.5	1.1
	0.13	0.2	0.6	3.5	2.9
Extreme Case	3.0	1.5	1.1	5.0	2.4
	1.6	1.5	1.1	5.0	2.9
	0.13	1.5	1.1	5.0	4.6
Total soluble inorganic nitrogen					
Mean	3.0	0.6	0.6	5.0	1.3
	1.6	0.6	0.6	5.0	1.8
	0.13	0.6	0.6	5.0	4.2
Extreme Case	3.0	2.1	1.1	8.5	3.8
	1.6	2.1	1.1	8.5	4.7
	0.13	2.1	1.1	8.5	7.8

Note: All concentrations are reported as N (reported concentrations in mg/l are measuring only nitrogen.) To convert nitrates ($NO_2 + NO_3$) as N to total nitrates, multiply by 4.4. To convert ammonia ($NH_3 + NH_4$) as N to total ammonia, multiply by 1.3. Total soluble inorganic nitrogen is primarily ammonia (NH_4) and nitrate (NO_3) compounds.

[1] Flow in Squirrel Creek is less than 3 cfs second about 75% of the time, less than 1.6 cfs 50% of the time, and less than 0.13 cfs 10% of the time (U.S. Geological Survey, unpublished data). Three representative flow rates less than 3 cfs were chosen.

[2] Mean and maximum concentrations are based on Consol, Kiewit Mining & Engineering, and U.S. Geological Survey periodic sampling of various locations along Squirrel Creek. Mean ammonia concentration from Kiewit Mining and Engineering monitoring station located near mouth, where creek crosses FAS 314 (sampling sites: SQ1 and SQB, 1977 to 1980).

[3] Consol estimates the average discharge from its operation at about 0.6 cfs (270 gpm) with a maximum discharge 1.1 cfs (500 gpm).

[4] Nitrate, ammonia, and total soluble inorganic nitrogen (as nitrogen). Concentrations are based on values found in mine discharges of the East and West Decker Mines and the Big Horn Mine (for 1978-83).

[5] Predicted Squirrel Creek concentrations were derived as follows: (Squirrel Creek flow x concentration + mine flow x concentration) divided by combined creek and mine flow = resultant concentration.

TABLE D-2

Wells That Would be Destroyed by Mining at the CX Ranch, Wolf Mountain, West Decker, and North Decker Mines

Consol No.	Location				Owner
	State	Township	Range	Section	
	Montana	8S	40E	33 NE¼SE¼SW¼NW¼	Decker Coal Company
3		9S	39E	14 NW¼NW¼SW¼SE¼	Consolidation Coal
5				24 SW¼SE¼SW¼SE¼	Consolidation Coal
6				25 SW¼SE¼SE¼	Consolidation Coal
8		9S	40E	3 SE¼SW¼SW¼SW¼	Decker Coal Company
9				3 SE¼SW¼SE¼SW¼	Decker Coal Company
10				3 NW¼NE¼SW¼SE¼	Decker Coal Company
11				4 NW¼SE¼SE¼SW¼	Decker Coal Company
24				17 SW¼NE¼SW¼NE¼	Decker Coal Company
41				30 SE¼SE¼NW¼NE¼	Consolidation Coal

TABLE D-3

Wells That Could Undergo Water Level Declines From Mining at CX Ranch, Wolf Mountain, West Decker, and North Decker Mines

Consol No.	Location				Owner
	State	Township	Range	Section	
	Montana	8S	40E	32 NW¼SE¼SW¼NE¼	Decker Coal Company
				32 SE¼NE¼NE¼SE¼	Decker Coal Company
				34 NE¼NW¼SE¼NW¼	Decker Coal Company
2		9S	39E	14 SE¼NE¼SE¼NW¼	Consolidation Coal
4				24 NE¼SE¼SW¼NE¼	Decker Coal Company
13		9S	40E	10 SW¼SE¼SW¼	Decker Coal Company
14				10 SE¼SE¼SW¼	Decker Coal Company
15				10 SE¼SE¼SW¼	Decker Coal Company
16				10 SE¼SE¼SE¼SW¼	Decker Coal Company
27				21 SW¼NE¼SE¼SW¼	Decker Coal Company
29				21 NW¼NW¼SE¼SW¼	Decker Coal Company
30				21 SE¼NW¼SE¼SW¼	Decker Coal Company
31				21 NW¼NW¼SW¼SE¼	Decker Coal Company
38				29 SE¼NE¼SW¼SW¼	Consolidation Coal
39				29 SE¼NE¼SW¼SW¼	A. McCarthy
40				29 NW¼SE¼NW¼SE¼	Squirrel Creek School
42				30 NE¼NW¼NW¼	Consolidation Coal
	Wyoming	58N	83W	20 NE¼SW¼	Sheridan Enterprises

TABLE D-4

Predicted Nitrogen Concentrations if the CX Ranch and Wolf Mountain Mines Simultaneously Discharge Water to Squirrel Creek During Low Flow

	Squirrel Creek Inputs		Mine Discharge Inputs		Resulting
	Flow[1] (cfs)	Quality[2] (mg/l)	Flow[3] (cfs)	Quality[4] (mg/l)	Quality[5] (mg/l)
Total ammonia					
	3.0	0.3	1.25	1.5	0.6
Mean	1.6	0.3	1.25	1.5	0.8
	0.13	0.3	1.25	1.5	1.4
Extreme case	3.0	1.6	2.3	3.5	2.4
	1.6	1.6	2.3	3.5	2.7
	0.13	1.6	2.3	3.5	3.4
Nitrates					
	3.0	0.2	1.25	3.5	1.2
Mean	1.6	0.2	1.25	3.5	1.6
	0.13	0.2	1.25	3.5	3.2
Extreme case	3.0	1.5	2.3	5.0	3.0
	1.6	1.5	2.3	5.0	3.6
	0.13	1.5	2.3	5.0	4.8
Total soluble inorganic nitrogen					
	3.0	0.5	1.25	5.0	1.8
Mean	1.6	0.5	1.25	5.0	2.5
	0.13	0.5	1.25	5.0	4.6
Extreme case	3.0	3.1	2.3	8.5	5.4
	1.6	3.1	2.3	8.5	6.3
	0.13	3.1	2.3	8.5	8.2

Note: Nitrate, ammonia, and total soluble inorganic nitrogen concentrations are reported in mg/l of nitrogen. To convert nitrate (NO_2 + NO_3) as N to nitrate multiply by 4.4. To convert ammonia (NH_3 + NH_4) as N to total ammonia multiply by 1.3. Total soluble inorganic nitrogen is composed primarily of nitrate (NO_3) and ammonia (NH_4) compounds.

[1] Flow in Squirrel Creek is less than 3 cfs 75% of the time, less than 1.6 cfs 50% of the time and less than 0.13 cfs 10% of the time (U.S. Geological Survey, unpublished data). Flow rates of 1, 2, or 3 cfs were selected as representative of various low-flow conditions.

[2] Mean and maximum concentrations are based on periodic samples taken by Consol, Kiewit Mining & Engineering, and the U.S. Geological Survey. Mean ammonia concentration from Kiewit Mining and Engineering monitoring station located near mouth, where creek crosses FAS 314 (sampling sites: SQ1 and SQB, 1977 to 1980).

[3] Consol estimates that the average discharge from its operation would be about 0.6 cfs, with a maximum discharge of 1.1 cfs. Kiewit Mining & Engineering estimates an average discharge of 0.65 cfs and a maximum discharge of 1.2 cfs. (Flow could be higher, but if it were nitrogen concentration would drop.)

[4] Nitrate, ammonia, and total soluble inorganic nitrogen (as N) concentrations are based upon values found in mine discharges of East and West Decker Mines and the Big Horn Mine in Wyoming from 1978 to 1983. (Unpublished data on file with Department of State Lands, Helena, Montana).

[5] Predicted Squirrel Creek concentrations were derived as follows: (Squirrel Creek flow x concentration + mine flow x concentration) divided by combined creek and mine flow = resultant concentration.

TABLE D-5

Predicted Nitrogen Concentrations in the Upstream End of the Tongue River Reservoir

	Historic Conditions (mg/l)	With 11 Mines (mg/l)	Percent Increase
Mean conditions[1]			
Total ammonia, as N	0.1	0.14	40%
Nitrates, as N	0.1	0.18	80
Total soluble inorganic nitrogen, as N	0.2	0.32	60
Extreme conditions[2]			
Total ammonia, as N	0.3	0.7	140%
Nitrates, as N	0.4	1.0	150
Total soluble inorganic nitrogen, as N	0.7	1.7	145

Note: Nitrate, ammonia, and total soluble inorganic nitrogen concentrations are reported in mg/l weight of nitrogen. To convert nitrate (NO_2 + NO_3) as N to nitrate multiply by 4.4. To convert ammonia (NH_3 + NH_4) as N to total ammonia multiply by 1.3. (Total soluble inorganic nitrogen is composed primarily of nitrate (NO_3) and ammonia (NH_4) compounds.)

Note: Changes in water quality constituents of the Tongue River Reservoir ignored the storage capacity of the reservoir (average about 40,000 acre-feet). The mean particle exchange rate of the reservoir is only about 35 days, so long-term pit discharges would approach the mean conditions. Extreme conditions in the reservoir would probably be less than reported due to the short duration of input conditions and the dilution factor of the reservoir.

[1] Tongue River: Fifty percent of the time Tongue River flow is less than 240 cfs. Mine discharges: flow 16 cfs, nitrates 2.5 mg/l, ammonia 1.6 mg/l, TSIN 4.1 mg/l. Premine ground water inflow to the river from the mine areas (subtracted from mine load): flow 4 cfs (modified from Van Voast and Thompson, 1982), nitrates 1.5 mg/l, ammonia 0.1 mg/l, TSIN 1.6 mg/l.

[2] Tongue River: Ten percent of the time, Tongue River flow is less than 140 cfs. Mine discharges: maximum flow 21 cfs, maximum nitrates 5.0 mg/l, maximum ammonia 3.5 mg/l, maximum TSIN 8.5 mg/l. Premining ground water inflow to river from the mine areas (subtracted from mine load): flow 4 cfs (modified from Van Voast and Thompson, 1982), nitrates 1.5 mg/l, ammonia 0.1 mg/l and TSIN 1.6 mg/l.

APPENDIX E

Scientific Names of Wildlife Species

TABLE E-1

Common and Scientific Names of Wildlife Species Discussed in the Text

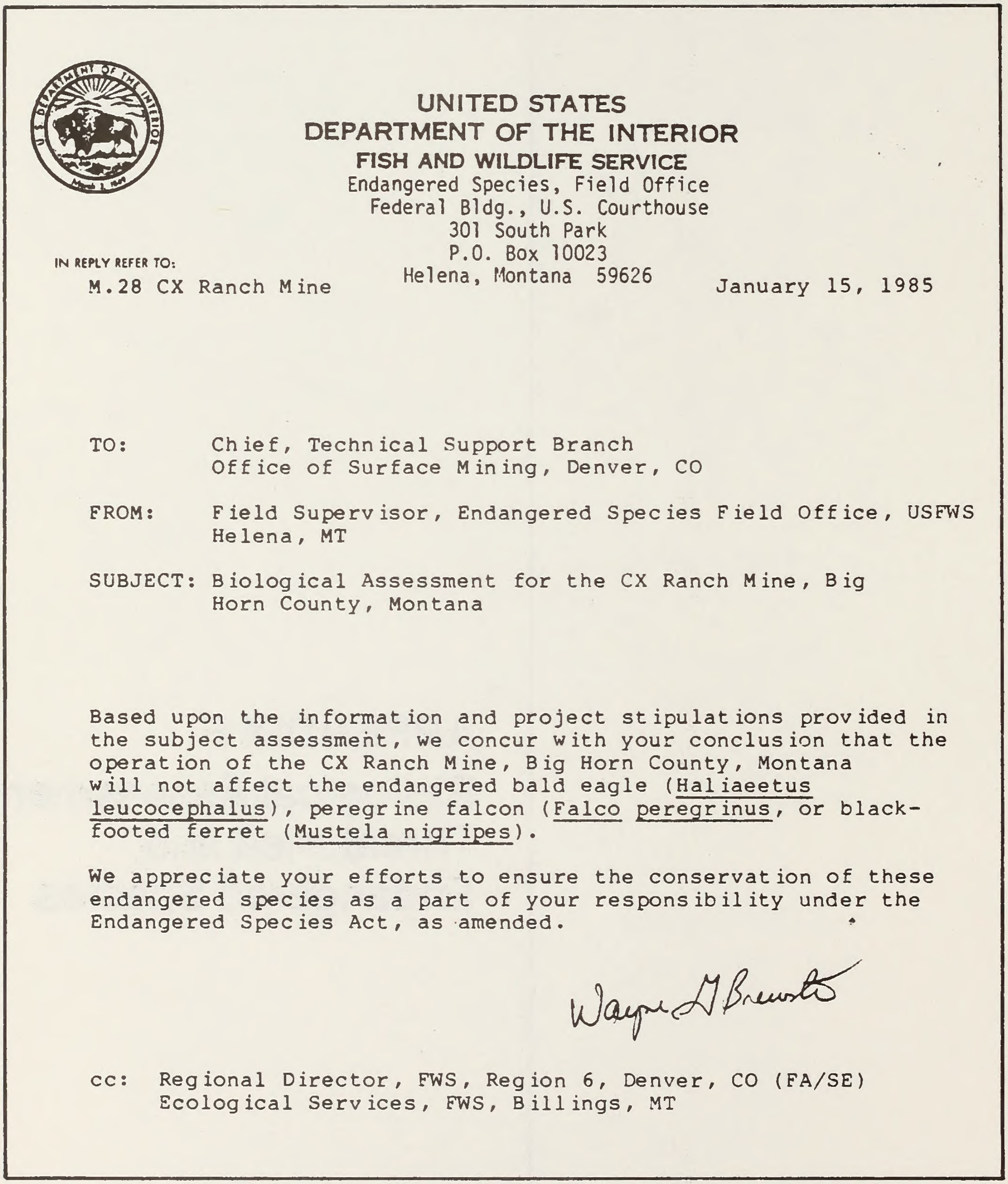
Common Name	Scientific Name
Mammals	
Mule deer	*Odocoileus hemionus*
Pronghorn antelope	*Antilocapra americana*
White-tailed deer	*Odocoileus virginianus*
Deer mouse	*Peromyscus maniculatus*
Masked shrew	*Sorex cinerus*
White-footed mouse	*Peromyscus leucopus*
Bushy-tailed woodrat	*Neotoma cinera*
Least chipmunk	*Eutamias minimus*
Thirteen-lined ground squirrel	*Citellus tridecemlineatus*
Black-tailed prairie dog	*Cynomys ludovicianus*
Beaver	*Castor canadensis*
Muskrat	*Ondatra zibethica*
Mink	*Mustela vison*
Striped skunk	*Mephitis mephitis*
Raccoon	*Procyon lotor*
Badger	*Taxidea taxus*
Coyote	*Canis latrans*
Pocket gopher	*Thomomys bottae*
Long-tailed weasel	*Mustela frenata*
Little brown bat	*Myotis lucifugus*
Bobcat	*Lynx rufus*
Yellow-bellied marmot	*Marmota flaviventris*
Pine squirrel	*Tamiasciurus hudsonicus*
White-tailed jackrabbit	*Lepus townsendii*
Desert cottontail	*Sylvilagus audubonii*
Black-footed ferret	*Mustela nigripes*
Birds	
Sage grouse	*Centrocercus urophasianus*
Sharp-tailed grouse	*Pediocetes phasianellus*
Ring-necked pheasant	*Phasianus colchicus*
Gray partridge	*Perdix perdix*
Great blue heron	*Ardea herodias*
Mallard	*Anas platyrhynchos*
Killdeer	*Charadrius vociferas*
Canada goose	*Branta canadensis*
Blue-winged teal	*Anas discors*
Green-winged teal	*Anas carolinensis*
Redhead	*Aythryza americana*
Common merganser	*Mergus merganser*
Double-crested cormorant	*Phalacrocorax auritus*
Golden eagle	*Aquila chrysaetos*
Prairie falcon	*Falco mexicanus*
Red-tailed hawk	*Buteo jamaicensis*
Great horned owl	*Bubo virginianus*
American kestrel	*Falco sparverius*
Black-billed magpie	*Pica pica*
Brewer's sparrow	*Spizella brewerii*
Vesper sparrow	*Pooecetes gramineus*

Common and Scientific Names of Wildlife
Species Discussed in the Text
(continued)

Common Name	Scientific Name
Birds (continued)	
Western meadowlark	*Sturnella neglecta*
Lark bunting	*Calamospiza melanocorys*
Yellow warbler	*Dendroica petechia*
Common grackle	*Quiscalus quiscula*
Red-winged blackbird	*Agelaius phoeniceus*
Bald eagle	*Haliaeetus leucocephalus*
Peregrine falcon	*Falco peregrinus*
Reptiles	
Prairie rattlesnake	*Crotalus viridis*
Bull snake	*Pituophis melanoleucus*
Garter snake	*Thamnophis* sp.
Yellow-bellied racer	*Coluber constrictor*
Sagebrush lizard	*Sceloporus graciosus*
Short-horned lizard	*Phrynosoma douglassi*
Painted turtle	*Chrysemys picta*
Snapping turtle	*Chelydra serpentina*
Amphibians	
Chorus frog	*Pseudacris triseriata*
Tiger salamander	*Ambystoma tigrinum*

APPENDIX F

Biological Assessment of Threatened and Endangered Species



UNITED STATES
DEPARTMENT OF THE INTERIOR
FISH AND WILDLIFE SERVICE
Endangered Species, Field Office
Federal Bldg., U.S. Courthouse
301 South Park
P.O. Box 10023
Helena, Montana 59626

IN REPLY REFER TO:
M.28 CX Ranch Mine

January 15, 1985

TO: Chief, Technical Support Branch
Office of Surface Mining, Denver, CO

FROM: Field Supervisor, Endangered Species Field Office, USFWS
Helena, MT

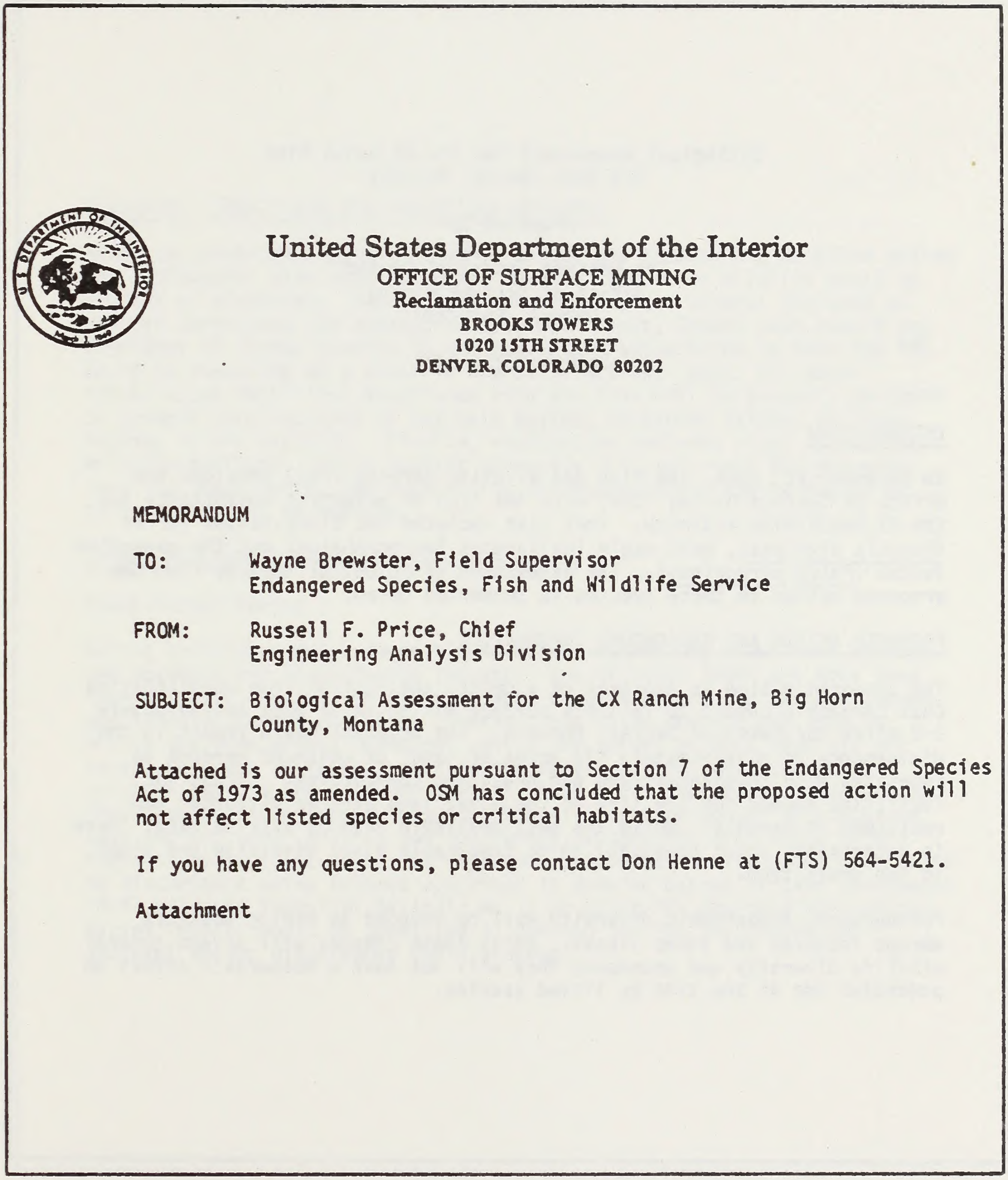
SUBJECT: Biological Assessment for the CX Ranch Mine, Big Horn County, Montana

Based upon the information and project stipulations provided in the subject assessment, we concur with your conclusion that the operation of the CX Ranch Mine, Big Horn County, Montana will not affect the endangered bald eagle (Haliaeetus leucocephalus), peregrine falcon (Falco peregrinus, or black-footed ferret (Mustela nigripes).

We appreciate your efforts to ensure the conservation of these endangered species as a part of your responsibility under the Endangered Species Act, as amended.

Wayne G Brewster

cc: Regional Director, FWS, Region 6, Denver, CO (FA/SE)
Ecological Services, FWS, Billings, MT



United States Department of the Interior
OFFICE OF SURFACE MINING
Reclamation and Enforcement
BROOKS TOWERS
1020 15TH STREET
DENVER, COLORADO 80202

MEMORANDUM

TO: Wayne Brewster, Field Supervisor
Endangered Species, Fish and Wildlife Service

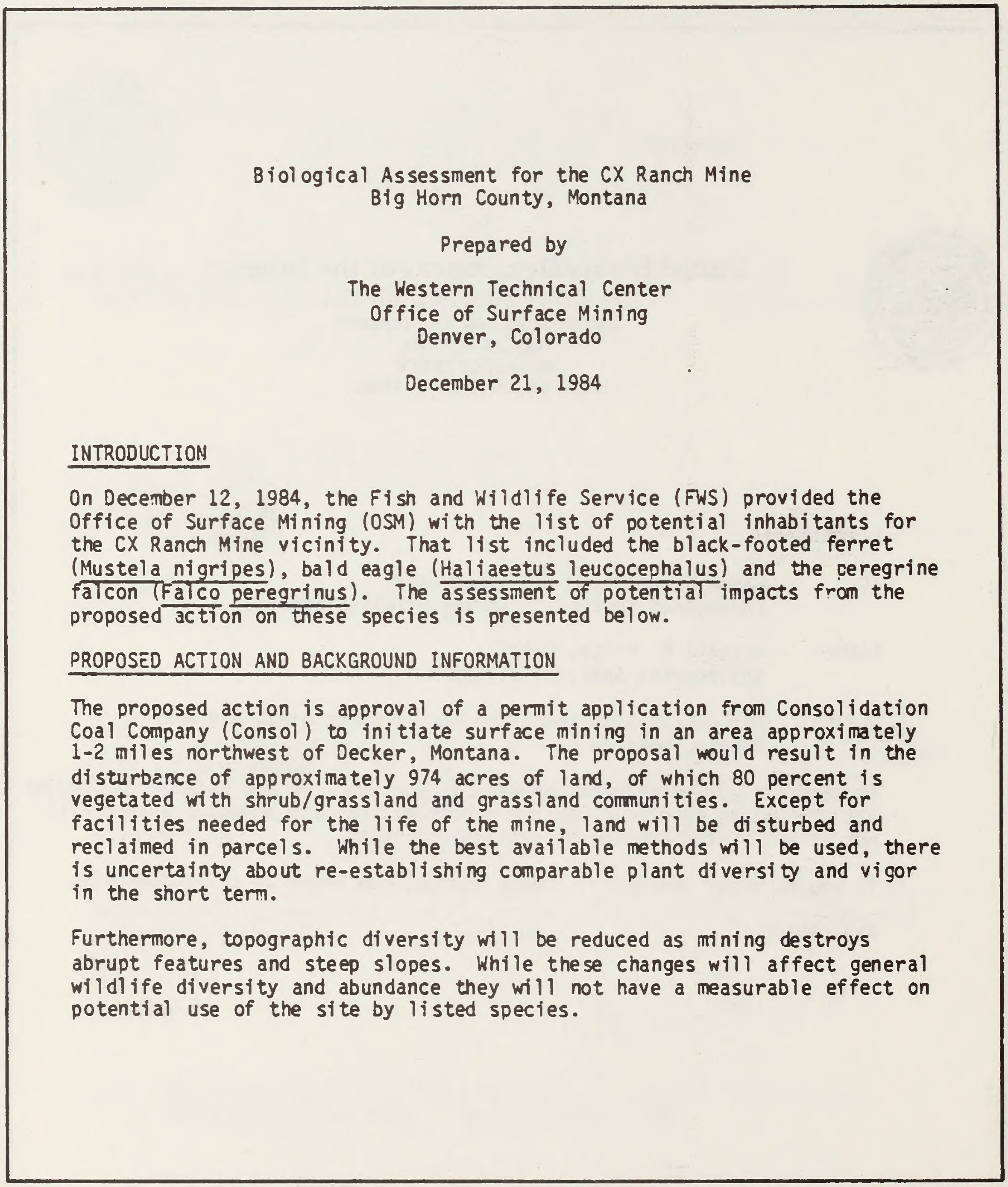
FROM: Russell F. Price, Chief
Engineering Analysis Division

SUBJECT: Biological Assessment for the CX Ranch Mine, Big Horn County, Montana

Attached is our assessment pursuant to Section 7 of the Endangered Species Act of 1973 as amended. OSM has concluded that the proposed action will not affect listed species or critical habitats.

If you have any questions, please contact Don Henne at (FTS) 564-5421.

Attachment



Biological Assessment for the CX Ranch Mine
Big Horn County, Montana

Prepared by

The Western Technical Center
Office of Surface Mining
Denver, Colorado

December 21, 1984

INTRODUCTION

On December 12, 1984, the Fish and Wildlife Service (FWS) provided the Office of Surface Mining (OSM) with the list of potential inhabitants for the CX Ranch Mine vicinity. That list included the black-footed ferret (*Mustela nigripes*), bald eagle (*Haliaeetus leucocephalus*) and the peregrine falcon (*Falco peregrinus*). The assessment of potential impacts from the proposed action on these species is presented below.

PROPOSED ACTION AND BACKGROUND INFORMATION

The proposed action is approval of a permit application from Consolidation Coal Company (Consol) to initiate surface mining in an area approximately 1-2 miles northwest of Decker, Montana. The proposal would result in the disturbance of approximately 974 acres of land, of which 80 percent is vegetated with shrub/grassland and grassland communities. Except for facilities needed for the life of the mine, land will be disturbed and reclaimed in parcels. While the best available methods will be used, there is uncertainty about re-establishing comparable plant diversity and vigor in the short term.

Furthermore, topographic diversity will be reduced as mining destroys abrupt features and steep slopes. While these changes will affect general wildlife diversity and abundance they will not have a measurable effect on potential use of the site by listed species.

REGULATORY COMPLIANCE AND PROTECTION MEASURES

Prior to receiving a permit to mine, Consol had to submit a detailed mining and reclamation plan describing how adverse impacts on wildlife would be avoided or minimized. Among these requirements are several designed to protect threatened and endangered species. First, Consol must report any sightings of listed species to the regulatory authorities so that the FWS could be consulted on a possible course of action. Next, all power transmission facilities associated with the mine will be properly designed to prevent electrocution of any bald eagles, peregrine falcons or other raptors in the vicinity. Finally, reclamation includes plans to restore wildlife habitats. While habitat diversity will not reach the pre-mine level for many years, the possibility of opportunistic use by eagles or falcons will not be reduced.

IMPACT ASSESSMENT

Black-footed Ferret

During baseline surveys three black-tailed prairie dog towns were located and surveyed for black-footed ferrets. Two of these towns are more than one-half mile outside the proposed area of disturbance and neither showed any signs of ferret activity. However, the third prairie dog town is within the mine permit boundary. While the survey of this town did not reveal evidence of ferret activity the survey methodology used was unidentified and the data are several years old. Therefore, to ensure no impact on possible ferret activity, OSM will require Consol to re-survey this and any other prairie dog town where disturbance will occur within one-half mile of the town. Surveys must be conducted within one year prior to disturbance using methods described in Wyoming Bureau of Land Management (BLM) Wildlife Technical Bulletin No. 1 or other FWS approved methodology. Survey results would be submitted to OSM and the FWS for review and approval before disturbance could proceed.

Bald Eagle

The bald eagle nests and winters in this area of Montana. The nearest bald eagle nest is about one and a half miles southwest of the CX Ranch permit area, along the Tongue River. The eagles are expected to rely heavily on the river and riparian habitats during the nesting season though they could range over the CX Ranch site. However, the CX Ranch site is not known to serve as a crucial or traditional feeding area for eagles. Similarly, wintering eagles are associated with the Tongue River and the Tongue River Reservior but could range over the permit area during searches for food. Individual eagles have been observed on the proposed mine site but there are no concentration areas or important food sources for eagles. Due to this opportunistic and infrequent use of the site, OSM has concluded that the proposed action will not affect the bald eagle.

Peregrine Falcon

This species is considered a migrant through the project area as there are no documented falcon nests in this portion of Montana. While sightings of transient falcons have been made in the area the proposed action will not measurably reduce the suitability of the site for migrating falcons. There will still be ample food supply and sufficient perch sites for the rare falcon visit. OSM has determined that the proposed action will not affect the peregrine falcon.

References

Consolidation Coal Company, 1983, Permit Application for the CX Ranch Mine, OSM, Western Technical Center, Denver, Colorado

Montana Department of State Lands and OSM, in preparation, Environmental Impact Statement for the CX Ranch Mine, OSM, Western Technical Center, Denver, Colorado.

APPENDIX G
Fisheries Data

TABLE G-1

Premining Temperature (°C) and Field pH, Squirrel Creek and Tongue River, December 1977-September 1981

	Spring		Summer		Fall		Winter		June Only	
	pH	Temp	pH	Temp	pH	Temp	pH	Temp	pH	Temp
Squirrel Creek mean	8.3	12.9	8.5	18.7	8.4[2]	3.7	7.9	1.5	8.3	18
Squirrel Creek maximum	8.9	19	10.2	20	8.8[2]	9.0	8.4	2.0	8.9	20
Squirrel Creek sample size	15	15	22	22	3	3	4	4	9	9
Tongue River mean	8.0	14.6	7.9	20.5	8.0	2.6	8.0	2.0	--[3]	--
Tongue River maximum	9.3	20	8.7	25.0	9.4	11.0	8.7	7.0	--	--
Tongue River sample size	15	15	10	10	5	5	4	4	--	--

Source: Consol (1983), KME (1983).

Note: Squirrel Creek was sampled at FAS 314. The Tongue River was sampled immediately upstream of the Tongue River Reservoir.

[1] Includes one temperature and one pH from sampling station at mouth of Squirrel Creek.

[2] One lab pH was substituted for an unusually high field pH.

[3] Not included in analyses.

TABLE G-2

Premining and Predicted Ammonia Concentrations at Mouth of Squirrel Creek During June

Possible Flows and Ammonia Concentrations				Resulting Quality
Premining Squirrel Creek[1]		Mine Discharges		During Mining
Ammonia Concentration (mg/l)	Flow (cfs)	Ammonia Concentration (mg/l)	Flow (cfs)	Ammonia (mg/l)
CX Ranch				
Mean conditions				
0.11	10	1.5	0.62	0.19
0.11	5	1.5	0.62	0.26
CX Ranch				
Extreme conditions				
1.6	5	5.5	1.1	2.3
1.6	1	5.5	1.1	3.6
CX Ranch Plus Wolf Mountain Mines				
Mean conditions				
0.11	10	1.5	1.1	0.24
0.11	5	1.5	1.1	0.35
CX Ranch Plus Wolf Mountain Mines				
Extreme conditions				
1.6	5	3.5	1.8	2.1
1.6	1	3.5	1.8	2.8

---

[1] Premining data from monitoring site maintained by Kiewit Mining and Engineering where creek crosses highway FAS 314 near mouth.

[2] Highest ammonia concentration recorded at Big Horn, West Decker, and East Decker discharges.

[3] Highest ammonia concentration with combined mines would be lower than highest concentration recorded at existing mines due to substantial inflow of alluvial ground water into the Wolf Mountain pit.

TABLE G-3

Percentage of Un-ionized Ammonia in Aqueous Ammonia Solutions at Different pHs and Temperatures

	(°C) 5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
pH	(°F) 41.0	42.8	44.6	46.4	48.2	50.0	51.8	53.6	55.4	57.2	59.0	60.8	62.6	64.4	66.2	68.0	69.8	71.6	73.4	75.2	77.0
6.5	.04	.04	.05	.05	.06	.06	.06	.07	.07	.08	.09	.09	.10	.10	.12	.13	.13	.14	.16	.17	.18
6.6	.05	.05	.06	.06	.07	.07	.08	.09	.09	.10	.10	.12	.13	.13	.15	.16	.17	.18	.20	.21	.22
6.7	.06	.07	.07	.08	.09	.09	.10	.11	.12	.13	.14	.15	.16	.17	.18	.20	.21	.23	.25	.26	.28
6.8	.08	.09	.09	.10	.11	.12	.13	.14	.15	.16	.17	.19	.20	.21	.23	.25	.27	.29	.31	.33	.35
6.9	.10	.11	.12	.13	.14	.15	.16	.17	.19	.20	.22	.23	.25	.27	.29	.32	.34	.36	.39	.42	.44
7.0	.12	.14	.15	.16	.17	.19	.20	.21	.24	.25	.27	.29	.31	.34	.37	.40	.42	.45	.49	.52	.55
7.1	.16	.17	.19	.20	.22	.23	.26	.27	.30	.32	.34	.37	.39	.42	.46	.50	.53	.57	.62	.66	.70
7.2	.20	.22	.23	.25	.27	.29	.32	.34	.37	.40	.43	.46	.50	.53	.58	.63	.67	.71	.77	.83	.88
7.3	.25	.27	.30	.32	.34	.37	.40	.43	.47	.51	.54	.58	.62	.67	.73	.79	.84	.90	.97	1.04	1.10
7.4	.31	.34	.37	.40	.43	.47	.51	.54	.59	.64	.68	.73	.78	.84	.91	.99	1.05	1.13	1.22	1.30	1.38
7.5	.39	.43	.47	.50	.54	.59	.64	.68	.74	.80	.85	.92	.98	1.06	1.15	1.24	1.32	1.42	1.53	1.63	1.73
7.6	.49	.54	.59	.63	.68	.74	.80	.85	.93	1.00	1.07	1.16	1.24	1.33	1.44	1.56	1.66	1.78	1.92	2.05	2.17
7.7	.62	.68	.74	.80	.86	.92	1.01	1.07	1.17	1.26	1.35	1.45	1.55	1.67	1.81	1.96	2.08	2.23	2.41	2.57	2.72
7.8	.78	.85	.93	1.00	1.08	1.16	1.27	1.35	1.46	1.58	1.69	1.82	1.95	2.09	2.26	2.45	2.61	2.79	3.01	3.21	3.39
7.9	.98	1.07	1.16	1.25	1.35	1.46	1.59	1.69	1.83	1.98	2.12	2.29	2.44	2.62	2.83	3.06	3.26	3.48	3.76	4.01	4.24
8.0	1.22	1.34	1.46	1.58	1.70	1.83	1.70	2.12	2.30	2.48	2.65	2.86	3.05	3.28	3.54	3.83	4.07	4.35	4.69	4.99	5.28
8.1	1.54	1.68	1.83	1.98	2.13	2.29	2.50	2.65	2.88	3.11	3.32	3.58	3.81	4.09	4.42	4.77	5.07	5.41	5.83	6.21	6.55
8.2	1.93	2.11	2.29	2.48	2.67	2.86	3.12	3.32	3.59	3.88	4.14	4.46	4.75	5.10	5.50	5.94	6.30	6.72	7.23	7.69	8.11
8.3	1.41	2.64	2.87	3.10	3.33	3.58	3.90	4.14	4.48	4.64	5.16	5.55	5.90	6.33	6.82	7.36	7.80	8.31	8.94	9.49	10.00
8.4	3.02	3.30	3.59	3.87	4.16	4.46	4.87	5.15	5.58	6.01	6.41	6.89	7.32	7.84	8.44	9.09	9.62	10.24	10.99	11.66	12.27
8.5	3.77	4.12	4.47	4.82	5.18	5.55	6.05	6.40	6.92	7.45	7.98	8.52	9.04	9.68	10.40	11.18	11.82	12.56	13.45	14.25	14.97
8.6	4.70	5.13	5.57	5.99	6.44	6.89	7.50	7.93	8.56	9.21	9.79	10.49	11.12	11.88	12.74	13.68	14.44	15.31	16.37	17.30	18.14
8.7	5.85	6.38	6.91	7.43	7.97	8.53	9.26	9.78	10.54	11.32	12.02	12.86	13.61	14.51	15.53	16.63	17.53	18.54	19.77	20.84	21.82
8.8	7.25	7.90	8.54	9.18	9.84	10.50	11.38	12.01	12.92	13.84	14.68	15.67	16.55	17.61	18.30	20.07	21.11	22.27	23.68	24.90	26.00
8.9	8.96	9.74	10.52	11.28	12.07	12.87	13.92	14.66	15.74	16.82	17.80	18.96	19.98	21.20	22.57	24.02	25.19	26.51	28.09	29.44	30.66
9.0	11.02	11.96	12.89	13.80	14.74	15.68	16.91	17.75	19.04	20.30	21.42	22.75	23.91	25.30	26.85	28.47	29.78	31.23	32.96	34.44	35.76

Source: Trussell, 1972.

TABLE G-4

Environmental Protection Agency Ambient Water Quality Criteria for Un-ionized Ammonia (mg/l NH_3)

pH	0°C	5°C	10°C	15°C	20°C	25°C	30°C
			Maximum Allowed Concentrations				
6.50	0.008	0.013	0.019	0.019	0.019	0.019	0.019
6.75	0.014	0.021	0.031	0.031	0.031	0.031	0.031
7.00	0.021	0.032	0.048	0.048	0.048	0.048	0.048
7.25	0.030	0.046	0.069	0.069	0.069	0.069	0.069
7.50	0.040	0.061	0.091	0.091	0.091	0.091	0.091
7.75	0.049	0.074	0.110	0.110	0.110	0.110	0.110
8.00	0.056	0.084	0.125	0.125	0.125	0.125	0.125
8.25	0.061	0.091	0.135	0.135	0.135	0.135	0.135
8.50	0.065	0.096	0.141	0.141	0.141	0.141	0.141
8.75	0.068	0.100	0.145	0.145	0.145	0.145	0.145
9.00	0.071	0.104	0.147	0.147	0.147	0.147	0.147
			30-Day Average Allowed Concentrations				
6.50	0.0018	0.0027	0.0040	0.0040	0.0040	0.0040	0.0040
6.75	0.0027	0.0041	0.0061	0.0061	0.0061	0.0061	0.0061
7.00	0.0042	0.0063	0.0094	0.0094	0.0094	0.0094	0.0094
7.25	0.0064	0.0096	0.0144	0.0144	0.0144	0.0144	0.0144
7.50	0.0098	0.0148	0.0220	0.0220	0.0220	0.0220	0.0220
7.75	0.0138	0.0208	0.0310	0.0310	0.0310	0.0310	0.0310
8.00	0.0139	0.0209	0.0310	0.0310	0.0310	0.0310	0.0310
8.25	0.0140	0.0210	0.0310	0.0310	0.0310	0.0310	0.0310
8.50	0.0142	0.0211	0.0310	0.0310	0.0310	0.0310	0.0310
8.75	0.0145	0.0214	0.0310	0.0310	0.0310	0.0310	0.0310
9.00	0.0150	0.0219	0.0310	0.0310	0.0310	0.0310	0.0310

Source: U.S. Environmental Protection Agency, 1983.

Note: To convert mg/l NH_3 to mg/l N, multiply by 0.822.

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AGENCY REVIEW

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PEOPLE, AGENCIES, AND COMPANIES CONSULTED

The following agencies and companies (other than those cited in the text) provided information used to analyze Consolidation Coal Company's mine plan:

Big Horn County Commission, Hardin, Montana

City of Sheridan, Sheridan, Wyoming

Crow Tribe of Indians

Kiewit Mining and Engineering Co., Sheridan, Wyoming

Montana Department of Commerce, Helena, Montana

Montana Department of Fish, Wildlife, and Parks, Helena, Montana

Montana Department of Health and Environmental Sciences, Air Quality Bureau, Helena, Montana

Montana Department of Health and Environmental Sciences, Water Quality Bureau, Helena, Montana

Montana Department of Highways, Helena, Montana

Montana Department of Institutions, Helena, Montana

Montana Department of Natural Resources and Conservation, Helena, Montana

Montana Department of Revenue, Helena, Montana

Montana Department of Social Rehabilitation Services, Helena, Montana

Montana Department of State Lands, Coal Bureau, Helena, Montana

Northern Cheyenne Planning Office, Lame Deer, Montana

Sheridan County Commission, Sheridan, Wyoming

State Historic Preservation Office, Helena, Montana

U.S. Department of Health and Human Services, Indian Health Services, Billings, Montana

U.S. Department of the Interior, Bureau of Indian Affairs, Billings, Montana

U.S. Department of the Interior, Bureau of Land Management, Billings, Montana

U.S. Department of the Interior, Bureau of Land Management, Miles City, Montana

The Department of State Lands and Office of Surface Mining appreciate the assistance of Consolidation Coal Company, which provided the Environmental Analysis Bureau with information on the proposed mine.

PUBLIC REVIEW

In accordance with environmental law, copies of this draft EIS will be made available to the public for comments and suggestions. All comments received will be carefully considered in the preparation of the final EIS. Comments can be sent to Commissioner Dennis Hemmer, Montana Department of State Lands, Capitol Station, Helena, MT 59620.

The draft EIS is available for review in the following places:

- Montana Department of State Lands, 1625 11th Avenue, Helena, Montana.
- Big Horn County Public Library, 419 North Custer Avenue, Hardin, Montana.
- Miles City Public Library, 1 South 10th, Miles City, Montana.
- The Rosebud County Library, 201 North 9th Avenue, Forsyth, Montana.
- Parmley Billings Public Library, 510 North Broadway, Billings, Montana.
- Sheridan County Fulmer Public Library, 320 N. Brooks, Sheridan, Wyoming.

Copies are also available on request from the Department of State Lands, Capitol Station, Helena, MT 59620.

Form 1279—3
(June 1984)

BORROWER

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Consolidation Co
CX Ranch mine,

DATE LOANED	BORROWER

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